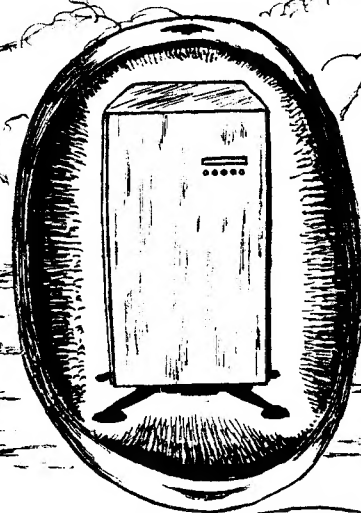
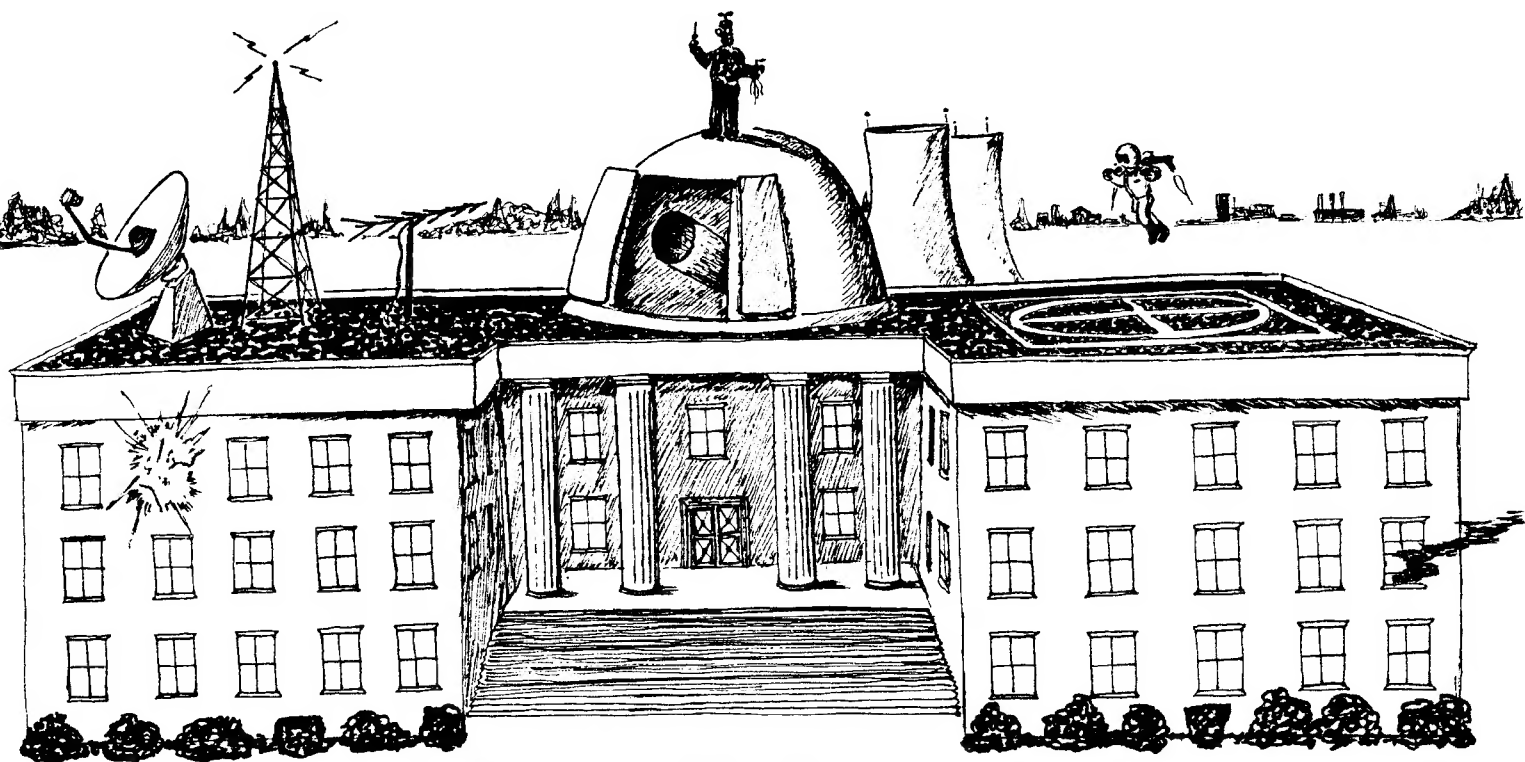




GEORGETTE TALLON
BUCKFAST



SHALMAN ESER



THE CAPITOL AT KALAMAZOO

APA·TECH: THE 51ST STATE

May 1987

The 555 Times #51

APA-TECH 51

The Amateur Press Association
that forgot the Answer to the Question,
"What is GT, anyhow?"

G.T. Buckfast (Regular Editor): Donna Proni, 530 W. Walnut St., Kalamazoo,
Mich. 49007 (616)-342-4967

Shalmaneser (Odd Editor): Greg Ruffa, 10380 Maya Linda Rd., Apt. C-303,
San Diego, Calif. 92126 (619)-695-8647

TABLE OF CONTENTS

Cover / Greg Ruffa	1
The 555 Times #51 / Shalmaneser	1
Index to Cover Art: APA-TECH 1 - 50 / Shalmaneser	3
North by Northwest by... / Rolf Wilson	5
Crumbcrunchers, Inc. / Susannah West and Dave Powell	6
Transporter Topics #45 / Rod Smith	4
Biting the Bullet / Bonnie Jones	1
Dr. Gonzo's Bits and Pieces / Valli Hoski	2
Just What I Needed to Fill this Page / Greg Ruffa	12
Amorphous Abstractions / Guy Wicker	2
Loused Up in Space / franked by Greg Ruffa	24
Out Where There Are No Ups and Downs / franked by Greg Ruffa	22
Space Station Team decal / franked by Greg Ruffa	—
page count	83

additions to APA-TECH 50:

I Suppose You'd Rather I Be John Philip Sousa? / Greg Ruffa	12
total	76

The deadline for APA-TECH 52 is Monday, June 1st at the House of Isher.
The copy count is 30 and minimum required activity is two pages every four months.

I'm afraid Al Duester has been dropped with this issue; Alice Bentley and the Trembleys are advised to send in contributions for next time. I imagine some of your accounts are low (but I don't know which ones); why not mail a check today?

It's been a bit slow here this month: probably to be expected after all the fine contributions of the last two months. The frankings really piled up, I'm afraid. The fellow who sends all that stuff wants to know how many of you read it and whether you want it to continue or if you feel it just eats up your postage. As for me, I plan to be at Westercon in Oakland and will be pleased to take your 'zines and money for July. Until then, hope your days'll be glitch-free!

Shal.

INDEX TO COVER ART

APA-TECH 1-50

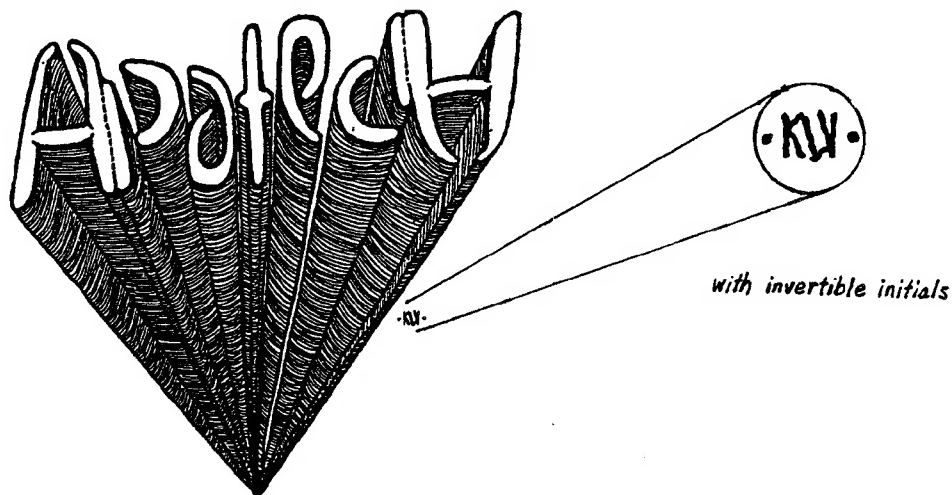
Issue	Theme	Artist	Medium*
1	printed circuit	Tullio Proni	ditto
2	"Hi There -- I Look Mundane": a message from National Mundane(-looking) Fandom	Matt Davison	ditto
3	spaceship in starscape	Sarah Prince	multi-color ditto
4	scorpion ship approaching mysterious sphere	Alice Insley & Phil Foglio	X
4p	Alice writing a hundred times on blackboard, "I will get my APA out by deadline"	Alice Insley	X
5	spaceship over planetscape	Donna Struwe	ditto
6	view from relativistic starship	Greg Ruffa	Xerox drawing & color felt-tips
7	First Anniversary Issue: elements from Silent Running	Marty Franz	X
7p	Viking landing to produce birthday cake	Greg Ruffa	X
8	bandersnatch	Doug Van Dorn	X
8p	alien musical duet	Alice Insley	X
9	"the very last Viking image"	Greg Ruffa	X
9p	spaceship at asteroid belt?: "where the space debris always collects"	Misha Sestak	X
9p	flying ships approaching floating city	Alice Insley	X
9p	man and rover on Mars	Rod Smith	X
10	Kzin with weapon	Mary Lynn Skirvin	X
10p	Uncle Greg and his phenomenal bedtime stories	Alice Insley	X
10shadow	The Shadow pulp cover: "Deadline of Doom" with Cranston P. Snerd	Bill Higgins	X
11	Spaceships issue: USA Eagle-2 leaving Moon?	Doug Van Dorn	X
12	Voyager-1 image of Jupiter with Io and Europa	NASA/JPL franked by Dave Levine	photo print
12p	cutaway diagram of Shuttle Orbiter	Steve Johnson	computer graphics
13	Second Anniversary and (In)appropriate Technology Issue: construction of orbital birthday cake	Greg Ruffa	X
14	spaceship model bursting through technical documentation	Bill Higgins	Xeroxed photo & collage

14p	texture of tiny APA-TECH logos	Rolf Wilson	pen plotter
15	GT ship escaping planetary explosion: "Nobody took this deadline seriously, either."	Marty Franz	X
16	view from aboard a skystalk	Greg Ruffa	X
17	spaceship in starscape	Dexter Dickinson franked by Al Duester	color Xerox of original painting
18	ransom note: "I have your APA-TECH 18 cover -- a friend"	Marty Franz	collage
18p	circuit diagram	Mike Bentley	X
19	Third Anniversary Issue: the infamous "Raman Candles" cover	Greg Ruffa	X
20	invertible logo (reproduced below)	Kip Williams	X
20p	"Down the Rabbit Hole with APA-TECH": logo spiralling inward	Rolf Wilson	pen plotter
21	APA-Truck	Greg Ruffa	X
22	man in coveralls supporting (or hanging from?) logo	Ronnie Osbourne	X
23	"In the Future, cartoons will be transmitted by telephone!": the infamous Mongolian Watermelon cover	Bill Higgins, Barry Gehm, & Greg Ruffa via telecon.	X
24	"Revenge Return of the Jedi": George contemplating new film title	Steve Salaba	X
24p	op art design with tech words	Bill Higgins	typewritten vocabulary with transparent overlay
25	Fourth Anniversary Issue: "It's About Time" with hourglass and scrambled pocket watch	John Frambach	X
26	"APA-TECH Express -- when you absolutely, positively have to have a cover overnight!"	Greg Ruffa	X
27	"Special Micro Issue": logo seen under magnifying glass	Marty Franz	X
28	Robots Issue: at the Robots' Cantina; with fold-out back cover: Toward A Robot Genealogy	Greg Ruffa	X
29	"APA-TECH 29, This Is Your Life!"	John Frambach	X
30	"Spring Issue!": with strange talking weed(?)	Marty Franz	X
31	Fifth Anniversary Issue: "Demon with the Wax Hand"	Greg Ruffa	X
32	Our 100000th Issue: depicts every active member of APA-TECH	Greg Ruffa	X
33	Istimirant Stella: contemporary parody of Bayreux Tapestry depicting Halley's Comet	Greg Ruffa	X

34	The World of APA-TECH in interrupted sinusoidal projection	Bonnie Jones	plotter
35	an APA-TECH raft "still drifting along"	Tullio Proni	X
36	Sixth Anniversary Issue: Map of the Land of APA-TECH, loaded with teeth-grinding puns (!)	Tullio Proni	X - wraparound
37	generic cover	Donna and Tullio Proni	X
38	control room scene with logo on screen	Eric Roman Nash	X
39	Variety front page with Ishercon headline	Steve Salaba	collage and computer-generated headlines
40	The Bear and Billy Show	Steve Salaba	X
41	Seventh Anniversary Issue: logo embedded in VLSI circuit	Guy Wicker	computer graphics
42	To Mars! and Back with APA-TECH	Greg Ruffa	X
43	Atrium Fliers	Greg Ruffa	X
44	angular flying craft	Eric Roman Nash	X
45	"Space — Keeping It Strong 'n' Free!"	Greg Ruffa	collage and rubber stamp montage
46	the infamous Exploding Catheads cover	Geoff Darrow	X
47	the Alien Artifact in search of Chuck Berry	Bonnie Jones	X
48	logo in starburst pattern	Alex Ellingsen	laserprinter
49	GT storefront with invertible logo	Annette Kavanaugh	X
50	spaceship approaching discontinuous etheric anomalous logo	Alice Bentley	X
50p	sheet music cover for The Invisible Eagle March	Greg Ruffa	collage

X - Xeroxed drawing

from AT #20:



North by Northwest by...

Rolf Wilson
611 W. Hill
Champaign, Il. 61820

Mailing Comments

Dr. Gonzo's Bits And Pieces

Good luck with your move to Italy. I can't really imagine making such a move myself - it was a major job getting us across town. Some people have "things". Like us.

Crumbcrunchers

Speaking of bread-baking (which I like to do) I have been trying to get people at work interested in the idea. The Cornell Bread Book by Clive and Jeanette McKay makes a nice gift. It is published by Dover, and only costs \$2. So far, I have purchased 8 of them, and have been handing them out as gifts. The one big discovery for some people has been that gallon-size Ziploc bags are good for keeping home made bread from drying out. It never does dry out, but it molds after about a week and a half.

Speaking of Vernors - I got used to the stuff when I lived in Michigan around 1980. But I remember people saying then that "it hasn't been the same since they stopped aging it all for 4 years in oak kegs."

The Adventures Of Uncle Bear

Flying... I've flown lots of times, but always in commercial airliners. But sometime this summer, some friends of mine in the local gliding club are going to take me up. They are buying a new glider, and it seems that a person of my (ahem) weight requires one of that size.

Re yr ct Barry - we aren't all ignorant of G & S

Re yr ct Connie - for me, what separates man from the beasts is my bedroom door. Otherwise, the beasts get in and sleep on the waterbed...

Borborygmus

Re yr ct Greg - I think the epigraphs Greg uses are out of songs heard on the radio. I have recognized one or two.

Falling Anvils

Calvin and Hobbes has been one of my favorite cartoon strips since I first saw it. I've been waiting for the book for at least a year. Of course, when it came out, I was the last one to hear about it, and looked in at least 5 bookstores that had all sold out.

Re yr ct Roxanne "nothing at all - ever" - it reminds me of a Dr. Who episode where a godlike "White Guardian" requests the doctor's help. Dr. Who asks what will happen if he refuses, and the answer is "Nothing - ever". This threat sufficed.

Gadget—Mad Yuppie

I found your mailing comments with the guess about how each one was printed much fun (Rolf Wilson, Apple Imagewriter I, Boston II)

Chicago style pizza can be found here in Champaign, and it matches up quite well with any I have had in Chicago, thank you.

Interesting Times

You can add me to the list of people who got sick after Ishercon. Whatever it was that got passed around there, it was **nasty**! Since you want RSVPs for Ishercon, fine. If you invite me, I will come. That early enough for you?

Out Of The Frying Pan

You can put me in the other half of the Known Universe. Unless you want to talk about your personal life, I will not ask. I hope you find out what it is that you want to do, and with whom. Good luck.

Amorphous Abstractions

I thought that you were kidding about the 17,000 hours in front of the TV. Then I did some mental multiplication, and concluded that you were right. I don't watch much TV now. But your example reminds me that "Gilligan's Island" will be engraved in my memory for as long as I live. Say, have you found a way to edit memories yet? I suppose even "Gilligan's Island" is worth keeping on backup somewhere...

Incorrect Thoughts

I much enjoyed the discussion about moving the Earth with rocket engines, but later I decided that all you would ever do is stir the air around somewhat, and not move the planet any.

Days Of Miracle And Wonder

Ah, the Grand Canyon. Someday Mary and I are going to take a raft ride down the Colorado and admire it. Expensive? Hardly - I plan to pay for it with spare change. I mean it. I dump my pocket change in a jar at home. Every year or so, I take it to the bank. It will take quite a few more years, but we should be able to manage it.

"...it resembles Santa's workshop at the North Pole..." Gosh, you get to go everywhere!

Bill doesn't have to worry too much about the shelf space in his apartment. I told him that I could design shelves to at least double the number of books it would hold

Archduke Ferdinand

Another Calvin and Hobbes cartoon! Actually, this one hangs on my fridge, along with an number of others. I like to clip cartoons that strike my fancy. Luckily, I have 2 refrigerators.

Transporter Topics

Phonics. If I have my terms straight, this is the "sound it out" method most of us learned to read. Many people feel that it works much better than some of the methods being used in the schools today. I plan to get around this problem by teaching any children we may have how to read before they start school. Check

out "Habitable Planets For Man" as a world-building text. It has a second edition, I think.

Thanksgiving is Sunday, July 26. Most of you know what I mean by this, but for any who don't... Several years ago, Mary had a bad stomach virus and couldn't eat anything at Thanksgiving dinner. So I promised her that we would have our own, sometime else. We did, and it was a success. Every year, more people have come - they don't have other plans like they would in November. Last year we had 28. This year, I expect more. Somewhere along the line, we expect to find out what the real capacity of our house is. You're all invited. Yes, I know some of you live a little too far away to seriously consider coming. I've just always figured that anyone who goes to the trouble of driving several hours to get here must be someone who would be interested in seeing me and my friends.

I brought a large bag of cookies to Ishercon this year and everyone asked for the recipe. Would you believe several people? Well, Bob Trembley anyway. Faced with such an overwhelming mandate, here it is.

OATMEAL CRISPS

- 1 cup shortening
- 1 cup brown sugar
- 1 cup granulated sugar
- 2 eggs
- 1 teaspoon vanilla
- 1.5 cups sifted flour
- 1 teaspoon salt
- 1 teaspoon baking soda
- 3 cups quick-cooking rolled oats
- .5 cups chopped walnuts
- .5 cups chocolate chips
- .5 cups raisins

Thoroughly cream shortening and sugars. Add eggs and vanilla. Beat well. Sift together flour, salt and soda: add to creamed mixture. Stir in rolled oats and nuts and raisins and chocolate chips. Mix.

Drop dough onto ungreased cookie sheet about 2" apart. Bake at 350 degrees about 10 minutes or until lightly browned. The original recipe says "makes 5 dozen", but I get maybe half that. (One of my favorite quotes is "What good is a small cookie?")

This is more or less my favorite cookie, the one that I grew up on. My mom got it from an oatmeal box, and embellished it with the nuts, chips and raisins.

Well, I finally got around to buying a hard disk for my Mac. A Jasmine 20-Megabyte. The next thing I bought was another 50 floppies, so I could do backups. Now I can finally find all my files.

So of course, Mary bought one of her toys about the same time. What she got was a Delta 14" bandsaw. Our basement shop is filling out, bit by bit.

When I worked in Michigan, I had a bad chair at work, an uncomfortable car seat, and an badly supported fold-out bed. Naturally, my back began to hurt. I got a better chair at work, and started sleeping on the floor, and it got better. All of this means that I should have known what was going to happen when I started a new job where all the chairs were bad. My back began hurting so badly that I had a hard time tying my shoes in the morning. I'm back to doing situps at night, which helps. At work, I finally gave up on them and went out and bought my own chair. I just hope I haven't caused any permanent problems.

Interesting office I have at work. It has a lab sink in it, so I have a water faucet and a steam faucet. Just what I wanted - an office that can be turned into a sauna.

Our kitchen renovation has made great progress. That's because we hired someone to do the wiring and drywall. I don't mind doing work, but there are just so many things I don't know. Every time I would get started, I would run into some question that I couldn't find an answer to. I hate to just barge ahead, so there I would stop. Maybe my efforts at home renovation will be limited to simple, time-consuming projects, like stripping woodwork. I was amazed at how much electric power went into the kitchen. Seven different circuits, counting the outside light and outlet. We have friends who don't have that many circuits in their entire house. But the microwave requires a circuit, as does the garbage disposal, dishwasher and maybe the refrigerator. Plus a lot of outlets. We also got some more wiring run in the shop. Now I have 110-volt outlets all over the place. Before, I had just one, which also had the furnace on it. If I did anything out of the ordinary, I would blow the fuse on the furnace. Yes, we have circuit breakers. For some reason, the furnace also has a fuse box. Now all we have left to do in the kitchen is wallpaper, cabinets and the drop ceiling. All. With any luck, the kitchen will be operational by "Thanksgiving". Maybe without a new ceiling, but operational. I don't know how many times I have mopped the floor from all the dust from the drywall...

Recently went to a performance of the Cambridge Buskars. "Buskar" is a word for street musician. These two people, one flute player and one accordion player found themselves out of cash in Europe, and decided to make some money playing songs. They ended up with a recording contract with Deutsche Grammophon. They do a lot of funny things, such as playing all 9 Beethoven symphonies in 35 seconds, but they really are enjoyable to listen to. You might want to try one of their records.

Just this last weekend (April 13) we got most of our garden in. Now I am getting some of the benefits from the large amount of work I did last year building the raised beds and preparing the soil. This year all I did was rake some junk off the top, and stir in some more compost. "Stir" is a good word. Even after a year, the soil is so loose that you can stick your hands right into it. Planting things is a snap. I'm that sort of lazy person - I'll do a lot of work once if it looks like it will save me more work in the future. Last year was our first real garden, and it did fairly well. The main things we learned were to buy disease-resistant varieties of tomatoes, and to watch out for cucumber beetles, which killed all our cucumber plants last year. Our entire garden consists of 64 square feet, but the techniques in "Square Foot Gardening" make that more than enough. Most people grow enough tomatoes for the neighborhood, and end up trying to give them away. We just want enough for us.

I'm ready to buy a car any time. As I said before, the only thing that we are waiting for is our money, which is tied up until May. Mary has been needing the car most evenings, and I have been feeling somewhat stranded. The 1987 Consumer Reports car issue added 2 more models for us to consider, the Ford Taurus and the Volkswagen Quantum. But the Quantum was eliminated when I found that the steering wheel dug into my leg, and was not adjustable. More than one car has been eliminated by the simple expedient of both of us trying it in a driving position. Mary has to be able to pull the seat forward without ending up with the steering wheel in her lap, and I have to be able to sit up, and push the seat all the way back. We don't really belong in the same car. Mary has decided to keep the old Chevette even when we buy something new. She can use it to drive the 7 blocks home at night from her job at the post office.

Some of you who haven't lived in the city all your life know what a "section" is as a measurement of area. 1 square mile. 640 acres. 5280 feet by 5280 feet. I

used to believe all that. Then I got the job of fixing a program that converts legal descriptions of land into X-Y coordinates. If there is a section out of the 56,000+ in Illinois that is actually 5280 feet on each side, I haven't found it yet. It's not just the places where rivers make the boundaries irregular, or Indian treaty lines slice them up. It's the fact that most of the section corners were located a long time ago, and not very well. I am told that some of them were marked by dropping rocks out of a boat until the rocks were above water. Much of Illinois used to flood each year. So you have all these strange sections, and have to make sense out of phrases such as "the northeast quarter of the northwest quarter" when the section looks less like a square and more like a decayed eggplant. Personally, I would rather see everyone use a nice X-Y grid. But that's not how legal descriptions work. Here is an actual legal description, being a piece of land that I inherited a small fraction of (before it was sold off).

Tract 1: Commencing at the Southwest corner of the Southeast Quarter of Section 19 in Township 18 North, Range 4 East of the 3rd Principal Meridian.; Thence West on the South line of said Section, 5 chains and 90 links; thence North 16 chains and 21 links; thence East 25 chains and 96 links to the West line of the East Half of the Southeast Quarter of said section 19; thence South 43 chains and 81 links to a stone; thence West to the West line of the Northeast Quarter of Section 30 Township 18 North, Range 4 East; thence North on said line to the place of beginning; Also, Commencing at the Southeast corner of said Section 19, thence West 20 chains and 6 links; thence North 18 chains and 30 links; thence East 20 chains and 6 links; thence South 18 chains and 21 links, to the place of beginning, situated in the County of Macon and State of Illinois, excepting, however, the right of way of the Illinois Central Railroad through a portion of said described premises as the said railroad right of way is now established, and excepting also the certain dedications for public highway purposes as the same now appear of record in the Recorder's Office of Macon County, Illinois, situated in Macon County, Illinois.

By the way - the program I was working on had a lot of useful code to locate points in sections that had been sliced by Indian treaty boundaries. I realized that with a little sleight-of-hand, this same code could be used for sections that were sliced by rivers. Of course, I had to LIE, and tell the program that the rivers were actually Indian Treaty Boundaries. So my program that finds good sections by means of lying greets you like this - WELCOME TO GOODSECT WITH DOCTORED TRUTH - I'm still waiting for someone to laugh.

Since I now have a spelling checker, I have been running my old apas and other things through it to build up a custom dictionary. This is the list of non-capitalized words that I have added to my standard dictionary so far: apa bandsaw bookstore boolean desktop drywall fannish frisbee goodbye hardcode heck jello laptop mainframe milkshake pixels recompile recursion refinishing relink seatbelt tablesaw teleport uncreate waterbed woodworking worldcon zine. I also have custom dictionaries for other things, such as working on the Known Space concordance. You might think that a spelling checker would have trouble with words like "cziltang brone", but once you put it in the custom dictionary once, it will keep you from spelling it incorrectly (or at least differently) each time after that. For example, I found that I had spelled "kpitlithtulum" 2 different ways. Can you blame me?

CRUMBRUNCHERS, INC.
Dave Powell and Susannah West
Box 98
Ripley, OH 45167
(513) 392-4549

Here I sit, pecking away with one hand, the other hand being used to glue together the wooden tailpiece of a toy airplane. The instructions on the glue bottle say, of course, clamp for a half hour. If I can just think of where a C-clamp is, I'll go get it.

The airplane is an absolutely beautiful orange and black tri-plane, with propeller and wheels that rotate; it was hand-made by the father of a friend. I gave it to Marlene for her Easter present. She's been playing with it a lot, making grindy airplane noises, and waving it in the air (Dave's been playing with it too, for that matter).

Well, yesterday, we were invaded by wasps. Dave, in attempting to swat a wasp with the fly-swatter, also crunched the airplane, which was sitting parked on the floor at his feet!

Big news! I've been accepted for the publishing course at Stanford. MAYBE it will even work out that all three of us can stay in a dorm on campus; I talked to the course coordinator last week and she thought it was a definite possibility.

We just realized that registration is on July 5, and here in Ripley, we're helping plan a big July 4 weekend celebration - it makes us feel wistful to think of missing some of it. This year is the 175th anniversary of Ripley's founding, so people want some associated hoopla. There was a whole week of celebration, complete with pageant, to commemorate the sesquicentennial, and though whatever happens this year won't be elaborate, 175 years of being a village should certainly be recognized!

Other events of possible note include heavy doses of religion: a weekend revival featuring a shouting evangelist who gesticulated wildly and had an incredible amount of presence, Good Friday and Easter services. As I've mentioned before, I maintain an uneasy truce with Christianity, but as contradictory as it may sound, I enjoy providing the music for these services immensely.

For the past few months, I've been unable to play the pipe organ - it's shrouded in plastic, as is the rest of the sanctuary. The sanctuary was to be replastered and painted, but in the process, some severe structural problems with the building (which is 150 years old) were discovered. The place has been swarming with structural engineers, I've been playing the piano and electronic organ in the Fellowship Hall, and worrying that the future of a beautiful 80+-year-old tracker organ is probably in jeopardy. (It also needs repairs - which are estimated at AT LEAST a few thousand dollars.)

All these repairs, and on Sundays, I rarely see more than 40 people, reflected in the mirror above the organ. And most of these people are middle-aged or older. (This, of course, with the exception of the aforementioned services, when the attendance swelled to between 70 and 80!)

I really don't think that, all comments to the contrary, anybody will be able to get us to shut up about parenting. Certainly, from the outside, looking in, every parent's parenting leaves something to be desired.

I, for example, was a bit indignant when I was in high school and baby-sitting occasionally for a little boy who was probably one and a half. He wasn't toilet-trained yet, and I thought rather righteously that he certainly should be. I know now that he wasn't old enough for that - he just didn't have the control or the language skills that are really necessary. (And, of course, I listened to Marlene's pediatrician, who said I should start on the toilet training at 18 months - which I now realize was too young also. Now, at two and a half, Marlene's very proud of being able to use the big toilet, but boy, the struggles we went through!)

However, just think for a moment - being parents is probably the single most important job we are ever asked to undertake in our entire lives, the most challenging, doubtless one of the most difficult (though also the most rewarding). It's also one for which we receive NO job training but which we are expected to perform with a high degree of perfection. If you saw an ad in the HELP WANTED column for being a parent, would you apply? If you received the amount of negative criticism in your job that a parent receives, wouldn't you be tempted to resign (with accompanying dramatics, of course)?.....I think Dave and I are perhaps more sensitive than other parents might be about this. As some of you probably know, we had a very rough time, emotionally, mentally and everything else, for about a year after Marlene was born. At times it seemed that the whole world was against us, and the wounds the experience left us with will never totally heal. (Hey Susannah, time to get off your soapbox!!)

Thanks, Kiran, for your bookshop reviews. We're looking forward to reading what you may have to say about bookshops in Cincinnati (we've not actually had the opportunity to discover too many, as almost all our trips there are strictly business).

I'm glad other people know about Parnassus on Wheels and The Haunted Bookshop! (I DO hope that more people than just booksellers know about these incredible books?) There is (or was - it's probably not extant anymore) a used bookshop in Wheeling, WV called "The Ultimate Paradox." Its owner posted Roger Mifflin's dictum about bookselling ("we sell no fakes or trashes") on his wall.

I do have some favorite bookshops, though - however, they are in Rochester, NY, and as I haven't been in Rochester for three years, I'll have to rely on John to tell me whether they're still there or not. (Not sure of the addresses, either, as I can't find my Rochester phone book.)

1. World Wide News: lots of everything, (all new books) mostly paperbacks according to my recollection, and these books arranged by publisher rather than author, which made for confusion. What impressed me most, however, was the fantastic collection of newspapers, not only from all over the US, but foreign parts as well. It was also the only bookstore I ever discovered that carried NEW SCIENTIST.
2. Maplewood Books/Total Information. Corner of Dewey and Driving Park: an amazing collection of technical resource books. When I introduced Dave to this bookshop, he went crazy buying all sorts of engineering reference books. The folks here were also incredibly willing to order books for me from small presses - the sort of books Waldenbooks told me they were unable to get.

3. Bryn Mawr Bookshop: a true "Haunted Bookshop." Run by Bryn Mawr alumnae, it was stocked with attic discoveries, donations, library discards and I don't know what else. Things like piles of old 78's, NATIONAL GEOGRAPHICS, obscure religious tomes, all sorts of categorized nonfiction and shelves of fiction....Lots of children's literature, too, which was my main reason for "haunting" this particular bookshop. I found a copy of ST NICHOLAS dating from the 1890s, a copy of Sperry Armstrong's Call It Courage, autographed by the author, and a hardcover copy of K.M. Peyton's Flambards, which I hadn't been able to order from the publisher through ANY bookstore.

Three pages! Yikes! Time for some mailing comments:

VALLI: Dave truly enjoyed his trip to Puerto Rico, after some initial trepidation (some of his comments: "Do they use American money?" "Does anyone speak English?" "Do I need a passport?"). He came home with lots of interesting insights into Puerto Rican politics, the state of affairs (or disrepair) in San Juan, and great enthusiasm for some of the cuisine. (He almost had me writing to the grandmother of a Puerto Rican friend to get the recipe for black bean soup, if I hadn't found a close approximation of the recipe in Diet for a Small Planet.)

Receiving overseas mail, is, for me, a real delight. I especially appreciate the stamps, and try to reciprocate when writing my friends in Europe and Asia by plastering my letters with neat-looking stamps. (Though it seems that US stamps just aren't as beautiful or exciting as, say, Japanese or Australian stamps!)

JOHN: What is new furniture money? We never have any! (Well, I guess I should take that back - our new furniture money gets spent on computers.) I imagine Dave will have some enthusiastic comments about flying (if he has a chance to write anything this month - he's incredibly busy working on this software project). He was very serious about getting his license both while he was in school and for a while after, but this project has gotten pushed far into the background since we got married.

DAVE L.: colorization is indeed a bit off-putting. I saw the colorized version of "Miracle on 34th Street" at Christmas, and it was really something of a shock (I suppose "It's a Wonderful Life" is being colorized too, if it hasn't already - sigh). They should reserve it for something like "Jezabel." (When I saw that movie a few years ago, my friend I was with complained that it wasn't in color. I mentioned this to my mom, and she was surprised, because she remembered the film as being in color! All that talk about the red gown, I guess.)

On the other side, Dave and I saw a silent film that had been tinted, and he just couldn't understand why it had been tinted. I do remember seeing a tinted version of John Barrymore's "The Beloved Rogue" which was much more dramatic and mysterious in the night scenes than it might have been otherwise. It made quite an impression on me. (I saw it in high school.)

Another word that doesn't exist is "alright."

4

Sure, having kids makes you crabby, irrational and upset, but that's (hopefully) a temporary state that crops up occasionally, rather than being perpetual. And certainly nobody has to have kids to exhibit these undesirable traits! You should hear Dave and me (especially around income tax time).

BILL AND BARRY: Your joint account of your adventures is very clever! I'd say it's definitely "further consideration" material (that's the category that comes just before "accepted").

ROXANNE: You're right, the E.L. Konigsberg book about the boy genius is great. For the benefit of those who haven't read it, or aren't "kiddie lit" fanatics, the title is (GEORGE) (it may be upper and lower case, I can't remember). George is the little man that lives inside the protagonist (whose name I've forgotten) and who helps him out by providing him with the answers to all sorts of complicated things. The kid is in 6th grade, and taking accelerated and/or high school classes. When I read this book, it gave me a terribly yearning feeling, especially the fact that he was taking organic chemistry. At the time, I was taking organic and just barely clinging by the skin of my teeth. I wanted somebody like George so badly I could taste it! (Okay, I admit it - I was reading this book when I was a sophomore in college. And yes, I dropped organic rather than suffer the ignominy of another D.)

Have you read Who Says It's a Woman's Job to Clean by Don Aslett? I think it's wonderful, but I'm not sure about Dave. I think that he hopes the book will raise my consciousness, rather than his! Really, if I didn't know better, I'd think that Tom Lehr wrote "She's My Girl" with me specifically in mind.

GREG: Gee, I wish I could get my dad to be as enthusiastic about computers as yours is! He's working on a variety of projects in which a computer could help immensely. But he says he doesn't think computers are here to stay! My aunt, who's 74, says she's glad she's old, because that gives her a reason for not learning about computers.

KIRAN: I'd been meaning to ask you for some time: How do your profs and fellow students react to your taking courses in fields other than your major? I discovered that some profs were irritated to discover that I wasn't a major, and really grumbled when I told them. After a few reactions like this, I'd go to the prof at the beginning of the quarter, outline my background, and ask if he/she thought the course would be appropriate for me to take for credit, or whether I should audit. I also recall some grumbling from a botany major in a plant ecology course I took; he felt that non-majors shouldn't be allowed to take the course. This made me feel a bit uncomfortable, as my field at that particular time was environmental education.

On the other hand, my undergraduate roommates, who were all music majors, tried to encourage me, a biology major, to take music courses. I was too shy to ever do this, but they did make me feel as intelligent as they were, even though I didn't have perfect pitch, and was only a pedestrian musician.

When you're doing your bookshop research in Cincinnati, remember we're just 60 miles away on US 52 - we LOVE to have visitors! (This invitation goes for everybody else too - though

maybe not all at once!) No bookshops in Ripley, sorry.

ROD: My favorite role playing games have been DNA replication and photosynthesis! I think one of my profs wanted to try mitosis and meiosis, too, but I didn't participate in that.

GUY W: We also are VCRless! Dave really pines for one so that he can tape the "Dr. Who" episodes which air on the Cincinnati PBS (WCET, the originators of "Liliias Yoga and You," should anyone have the slightest interest) station Saturday evenings starting at 10. When some of the stories are put together to make movies they run 160 minutes sometimes! Who can stay awake for that?

WCET also occasionally runs two "Dr. Who"'s back to back, which necessitates staying up until about 3 in the morning. The only reason I can see for this is that they have the rights only for a limited time, and so must show all that they have within that time.

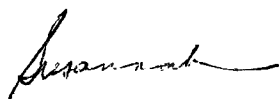
I myself can rarely stay awake past 11:30 or 12, even with Dave poking me in the ribs and shouting for me to wake up. I know that my Sunday morning schedule runs something like this: 6 AM: arise and shower; 7 AM: go over to church, practice organ and find out what hymns will be sung for the morning service; 8 AM: go home because Marlene will be waking up; 8:30 or 9 AM: get breakfast, get Marlene and myself dressed (me for church, she just dressed); 10:30 AM: leave for church....

We'd also like to get a video camera to tape Marlene in action.

LINDA: Another question that I've been meaning to ask for some time, but keep forgetting - what is your feeling about the state of SF in Japan? Our friend Ken Wright, who lives in Kyoto, told me that a good portion of English language SF has been translated into Japanese, but the same cannot be said for Japanese into English. He felt that this was a definite shame. (Ken is only a "pen-friend" who has sent me several stories, including one I have to get back to him. I really know little about him - what firm he might work for, how long he's been in Japan, what he does for a living, if he's married - but his writing offers some interesting insights into Japanese society without actually saying that the stories are set in Japan.)

I sense the end of the page approaching, and I think that five pages of rambling from me is probably quite enough for you! Besides, "Sesame Street" is over, and Marlene has just come crawling into the office, telling me that she wants to turn this machine off. "I want to do it by myself. I want me a pickup and do it by myself!" Well, you get the idea. I'm not sure it's wise to show her how to do this, however. Dave tacked on three extra procedures you have to go through to get back to DOS, just to prevent Marlene-caused mishaps like the one that wiped our hard disk a few months ago.

Be well and happy.



6

Somehow I find it hard to think of a Hot Brown as being baked road kill covered with boiled Velveeta, so I thought I'd rise to the defense of this sandwich! (However, I must hasten to add that I've never visited the Roanoke Hotel.)

6. The Advertiser, Maysville, Ky., Wednesday, April 15, 1987

Kentucky Hot Brown

a great sandwich

ROANOKE, Va. — We want to remain welcome visitors in the state of Kentucky, so we shall begin this ode to one of America's great sandwiches by making it clear that the hot brown is a product of Louisville.

It was originated by the Brown Hotel; and it was called a HOT brown to distinguish it from the Kentucky hotel's other well-known sandwich, which was a COLD brown. The cold one was a summertime special: open-face turkey, tomato, hard-boiled egg and Thousand Island dressing on crustless rye. Its traditional companion was a wide glass of iced tea in which a scoop of lime or lemon sherbet was set to float.

The original hot brown was a cold-weather meal: turkey and crisp-cooked bacon on toast topped with creamy melted cheese sauce. The basic idea has since proliferated throughout the mid-South, where one finds hot brown sandwiches made with chicken or turkey, with bacon or ham, with cream sauce, cheese sauce or pepper gravy, served on white bread, rye bread, dinner rolls or jumbo biscuits.

One of the most interesting and elaborate variations on the theme was created at the Roanoke Hotel in Roanoke, Va., whose Regency Room has been known as a citadel of gourmet cooking since 1882. A great Tudor edifice across from the Roanoke & Western Railway tracks, the hotel with its broad front lawn is truly a grand-looking place, reminiscent of an era before high-rise tower of glass.

Its cuisine is the finest Old Dominion fancy food, including such Jeffersonian glories as a dessert of

"crepes souffle a la Shenandoah" filled with orange-tinged meringue and topped with rum sauce.

The Regency Room's Kentucky hot brown is like no other we've sampled. Unlike most quickie hot browns, it requires advanced planning to make the Italian sauce. The results are more substantial than any ordinary sandwich. This recipe, which we adapted from the Regency Room's pamphlet of "Most Requested Recipes," makes a hearty meal for six. All you need to round it out is a small green salad.

Kentucky Hot Brown

Italian Meat Sauce

- ¼ cup olive oil
- 2 medium onions, finely chopped
- 2 cloves garlic, finely chopped
- ¼ pound lean ground beef
- ½ cup tomato paste
- 1 cup chicken stock
- ½ cup dry white wine
- 2 bay leaves
- ½ teaspoon oregano
- salt and pepper to taste

Heat olive oil over medium heat in large skillet. Saute onions and garlic. When onions soften, add meat, stirring with a fork to keep it pebbly. When well-browned, stir in tomato paste. Cook 2 minutes. Add chicken stock, wine, bay leaves and oregano. Stir and taste. Add salt and pepper to taste (you won't likely need salt if using canned chicken stock). Lower heat, cover and simmer, stirring occasionally, 2 hours. Sauce should be quite thick. If not, uncover for final 15 minutes of cooking time. Remove bay leaves.

Cheese sauce

- 3 tablespoons butter
- ½ cup minced onion
- 3 tablespoons flour
- 2½ cups warm milk
- 1 cup finely chopped Swiss cheese
- 1 bay leaf
- ½ teaspoon white pepper
- ½ cup dry white wine

In a medium-size saucepan, saute onion in butter until soft. Sprinkle in flour, stirring constantly. Cook over low heat 3-5 minutes, stirring until smooth. Slowly add warm milk. Continue stirring with a wooden spoon. As sauce thickens, stir in cheese. Add bay leaf and white wine. Add white pepper. Cook over low heat 20 minutes, stirring very frequently. Remove bay leaf.

To assemble sandwiches

6 Large, thick slices white bread, well toasted

- Italian meat sauce (above recipe)
- ½ pound white meat turkey, sliced
- 18 strips bacon, cooked crisp
- Cheese sauce (above recipe)
- 1 beefsteak tomato, sliced

Preheat oven to 400 degrees. Place toast on ovenproof serving dish or dishes. Spread Italian sauce on toast. Layer with turkey and bacon. Top with cheese sauce. Garnish with tomato. Bake 10-15 minutes, until sauce is bubbly. Serve immediately.

Serves 6.

TRANSPORTER
TOPICS

Rodford E. Smith
730 Cline St.
Frankfort, KY 40601
(502) 227-7741

Number 45

TYPING WITH A CAT ON MY LAP

From the response to my recent 'zines it would appear that I have been more dogmatic lately than usual. I'll try to watch it. Part of the problem is my abbreviated style of writing. I often leave out important modifiers.

MAILING COMMENTS

555 Times: I do not owe money. I recently sent you (Donna) a check which has been cashed but which does not show on the account history you included in #50. *

Notes From the Chair: A two-page cover. Hmmm... *

Dr. Gonzo: Puerto Rico. Wow. * You're moving to Milan? What is this, a conspiracy to get all members of APA-Tech out of the country? *

Crumbcrunchers: With all this talk about regional American cooking, maybe I should include info on how to prepare country ham. * As someone who is interested in Historical Anthropology and who lives in a town which is practically one big museum, I find the reticence of the locals concerning the steps disappointing. * Congratulations to Dave on passing the EIT and PE exams. (Remember the discussion we had on the subject during our trip to Ishercon?) *

Uncle Bear: What is the origin of your beginning paraphrase? It is familiar but I can't place it. * A local fannish friend of mine has his license and we talk airplanes a lot. In fact, he and I and two others were supposed to rent a plane and fly to Atlanta for the Worldcon last year. Unfortunately, the weather did not cooperate and we drove instead. On the way down the pilot kept looking out the window and cursing the weather forecasters, because he didn't see anything which would have caused trouble. On the way back, however, he admitted it was too bad for flying. There was a lot of what he referred to as "cumulus granitus" (the clouds were touching the mountains). * Your idea about things not seeming real until you put your glasses on echoes an effect I noticed several years ago. Whenever I had to do something that required removal of my glasses (such as swimming) that period seemed dreamlike and unreal. Since I have been taking Karate, however, this has changed. I work out with my glasses off. Now I am used to straining as much information as possible from blurred

vision and my other senses. * The State library is in Frankfort and used to be very near my home. My mother is a book reader and as kids my sister and I got taken there fairly often. I read a lot of old books, like some of the original Tom Swift series and some rarely reprinted Verne and Welles. *

Left Turn At Albuquerque: My word processor's dictionary didn't have "Albuquerque" in it. It does now. * Your van trip reminds me of how my father would bring home school busses to convert into campers. * I have not had salt bread. I intend to wear a dust mask from now on when I bake with yeast. *

Fractured Fractals: (Hmmm... Didn't have "fractals" either.) Your payload exercise is the sort of mental game I enjoy. For under 100 Kilos I would go for the largest Dobsonian telescope that would fit, at least 10 inches and maybe up to fourteen. Put a high-resolution CCD camera with a filter wheel at the focus. Add a nice, big dish antenna connected to a triply redundant transceiver, solar cells and batteries, gyroscopic attitude control with four gyros, a triply redundant computer system to control everything, a sun sensor and two star sensors for navigation and a propulsion system for making and adjusting orbit. Then send the thing to Mars. On the way it could do general astronomy. Once there it could make high-resolution images of Mars and the moons for mapping purposes. If there is still room, add (in order of priority) a second camera with peak sensitivity in the far UV range, larger batteries, an optical flat over the aperture to protect the lens (rigged to be discarded if it gets damaged or hazy), an extra gyro, a radio receiver connected to a direction finder (If the probe loses it's directional fix the computer would use this to point the main antenna at the strongest radio source. Unless something has gone very wrong, that would be Earth.), a smaller 'scope and camera to be used for sighting and panoramic shots. If designed and constructed with the same methods used for the various amsats and the Amateur Space Telescope it could probably hold all this and more. * My comments about SDI being useless offensively were made before I heard about adaptive optics and conjugate phase mirrors. Laser satellites would still not be practical for use against ground targets. Too expensive. *

Borborygmus: See above for SDI material. Concerning software, I think there will have to be some sort of revolution in the way programs are written and implemented sooner or later anyway. * Yes, there really is a Krypton, KY. There is also a Fleming-Neon. Apparently, someone liked noble gasses. * Concerning the bears: who cares about fame if you're rich? (Joke.) * The silhouette target is sixteen inches but only goes down to the hips. Add another foot for the legs and it is about two and a half feet. It was advertised as quarter scale; does that mean that the manufacturers weren't people? I don't feel uncomfortable shooting at man-shaped targets for the same reasons certain people I could name don't feel uncomfortable about defusing fake bombs. I know it isn't real. Conversely, I detest

Lazer Tag and the paintball games which teach shooting at real people. * I didn't see the *Magnus* parody. *

Idiotic Exploding Anvils: My paper doesn't get *Calvin and Hobbes* but the few examples I have seen have been good. I also agree with this particular installment's sentiments. Gimme that ol' time humor! *

Gadget-Mad Yuppie: Congratulations on your new arrival. Personally, I wouldn't own a computer I could easily pick up; I might throw it across the room sometime. * Your "Gadget-Mad Yuppie" routine sounds more like the ads for a grade B horror movie than a song. * Strange how we both came down hard on colorization in the same issue. * The history of Human evolution is a long tale of gradually increasing retention of juvenile characteristics. That is why we are (mostly) hairless, have disproportionately large heads and live so long for mammals our size. The majority of authorities in Anthropology and related fields accept the neoteny of humans as a given. *

Interesting Lives: (Sounds like a mini-series!) Re. Yr. Cmmt. Jamie: I still have my second official GT name badge. (I lost my first and had to pay for a replacement. I forget who made them.) * Concerning writing while sick; I have a restless temperament and can only stand so much time in bed. Even sick, I would rather be reading or writing than just lying there, suffering. * I fully intend to attend another Ishercon, someday. Just when, I couldn't say. * Too bad about your burglary. Glad you have good insurance. *

Pan-fried Whatever: Spending time talking is sometimes the best thing you can do, especially in situations involving emotional turmoil. Even if the listener can't offer a solution, putting your thoughts into words helps you make your own decisions. * I was reared just outside a small country town in the foothills of the Appalachians. I didn't get my first car until I was about eighteen. *

Abstract Guy: You gave one of the best explanations of how superconductors work I have read or heard, but I still don't understand how this will help electronics. How can you have a superconducting semiconductor? Does the speed of electrons through superconducting wire increase? *

Incorrect Marty: I had a *Traveller* campaign where the players came into a lot of money and had fun designing a ship. There were long discussions about whether to emphasize drives or weapons. * I like cars, especially all the engineering tricks you can use to improve them. * To change the Earth's orbit using a rocket, the exhaust velocity must significantly higher than escape velocity. Enough higher so that it can punch through the atmosphere and keep on going. Otherwise, you get no reaction to push on the Earth. You plant the engine anywhere it will face directly against the direction of movement. Since the Earth's axis is tilted that gives you a fairly wide latitude of choices, but limits when you can fire to sunrise every day for few weeks a year. *

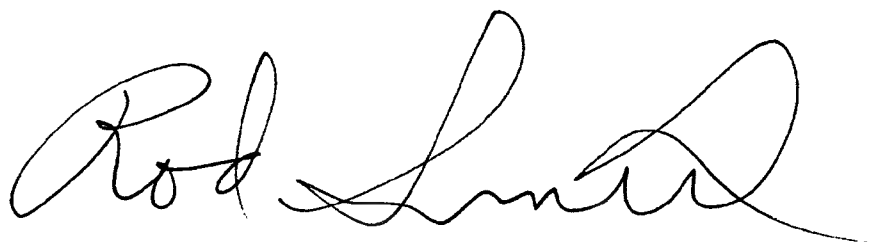
Miracle and Wonder, the Day Twins: Wait a minute, guys! I thought you both were furry and cute! (Beard joke. I just shaved mine off.) * Maybe MZB was just having a bad day, but she sounds rather closed-minded. * I thought all the Sea Darts were scrapped! * There is good reason to drive with extreme caution in California during a rain. The coating of pollution, oil, rubber & c. on the surface emulsifies with the addition of water, making a nearly frictionless coating. In most parts of the country this is washed off often enough to keep it from being much of a hazard; in California, however...! *

World's Most Shocking Headline: Ah, yes, Starwisp! Chickenwire to the stars. (It slices, it dices, it makes...!) * I got the *Blue Angel* catalog, too. Also got one last year. * There is a fun little book store in Lexington called The Book Exchange. Shelves go from floor to a full arm's reach high, and are stacked very close together. A real firetrap. * The Soviet administration tried to cover up the loss of their booster. (Brevity strikes again.) *

Militant Transparent Birds of Prey: My boss has been on jury duty quite a lot lately. * Have you heard about the atomic batteries one company has come up with? they use a slug of radioisotope in the middle of a thick electrolyte gel. The ionizing radiation from the isotope recharges the electrolyte. Funny thing is, I came up with a very similar widget as part of a story idea just a few days before reading about this! * The object is labeled as a comet because of its high albedo. * Ouch! I hadn't done the math in the power requirements, figuring I was safe if I just kept below what Niven had used for the accelerations of his fusion drive ships. Lets see, if you make the exhaust velocity truly relativistic, say 200 million m/sec, that gives a specific impulse of --- ummm --- 6,211,801 seconds. That, in turn, gives --- urgh --- (I gotta get a scientific calculator) 13,000 GW. Oops! It gets worse! Sometimes I think I'm just not cut out for writing hard SF. Too lazy. Can you recommend some good references in this and related fields? *

END MAILING COMMENTS

This thing is too long already. Good Bye!

A handwritten signature in black ink, appearing to read "Rod Lurie". The signature is fluid and cursive, with a large loop at the end.

BITING THE BULLET

Bonnie Jones
129 Burcham #1
East Lansing, MI 48823

Since other people are still discussing Ishercon, I thought I would throw my two cents in and bring up something that Joah talked about. I didn't mind the bomb disposal units. In fact, I thought it was a great exercise in puzzle solving. However, when it comes to armed combat, that's where I draw the line.

It started out small, a couple of people in the living room shooting plastic bullets at each other, but then it got out of hand. I found it impossible to sit in the living room and play a game or even carry on a conversation without pillow protection. Moving into the dining room didn't help, there were still yellow bullets whizzing past my head. I have a great fear of guns and projectiles, and I am especially sensitive about my eyes so I had to confine myself to the computer room or the kitchen or stay at Marty's house. I was afraid to use the stairway for fear of random shots. I had hoped this so-called form of fun would die down, but instead it escalated the next day when people went out and bought more guns and ammo.

Now, I can hear some of you saying that the bullets don't hurt much, just sting a little, but it does hurt when someone who I consider a friend comes up to within two feet of me, smiles and shoots me, knowing full well that I am not playing and have nothing to defend myself with. (This happened to me more than once.) I also think that it is a bad idea to have small pieces of plastic lying everywhere when there are two small children in the house that can easily pick them up and swallow them.

You might think that I am an isolated case, but I was not the only one who felt uncomfortable and restricted in moving about the house.

As you can see, I feel strongly about this. I attend Ishercon to visit with my friends but I was unable to do so in the middle of a battle zone. Now, I realize that a weapons policy at Ishercon would be a contradiction in terms. However, if I had known ahead of time the events that took place, I would have had second thoughts about attending the party.

Now, on to more pleasant things. I just got back from the annual meeting of the Association of American Geographers, held this time in Portland, Oregon. The weather was warm and sunny the six days we were there, which even amazed the natives. I got to see Mount Hood and the Columbia River. The Hilton hotel was centrally located downtown so that everything was within walking distance. Portland has more restaurants per capita than any other U.S. city, so the natives tell me and they have a wonderful used bookstore that has 750,000 volumes! I was really impressed that downtown was always busy and full of people, mostly young people from the nearby University. Bye.

Dr. Gonzo's Bits & Pieces

continuing the stroll down memory and LowTech Lane with a backup ditto-zine from Valli Hoski, 228-D S. Maple, Oak Park IL 60302 and (312) 383-3864. April, 1987.

If this comes as a photocopied dot matrix zine, then you've got the backup & Greg didn't have ditto facilities

As Blue as the Caribbean...

That last batch of ditto masters I used were standard purple and a sort of blue color, not the nice green I expected. So this time I am not bothering with the 2 color format. Maybe I can scare up some other colors locally or else wait until my next weekend in Chicago.

This zine is coming to you in Real Time (and real mistakes) in San Juan. For repro purposes I am still using ditto, but sadly missing the edit capability of the PC. And no, I don't know of any easily available thermo ditto master facilities, otherwise I would avail myself of that technology.

Life in the Beach Lane

Hey Jamie, you too Greg. You think you have it made in sunny San Diego? You should see it here...beaches, palm trees, sun, sand, surf. Too bad I have to work during the day. If you folks ever want to see what real beach life is like, come & visit.

Actually, Puerto Rico is quite different from California, even from the U.S. The culture, attitudes, atmosphere all are more Latin than American. The tongue is Spanish, but the towns, buildings, people, cafes all could be from a southern Italian town. For the first few weeks, I found myself talking to shopkeepers and the locals in Italian because it is so similar to the corresponding Spanish phrases.

My assignment here is with the Puerto Rican Treasury Dept. as part of a team to design and install a new tax processing system. Tax reforms are afoot here just as in the states. So our job (...should we decide to accept it...hopefully will not self-destruct...) is to automate their current processing with new features and functions to more speedily and accurately do returns.

Back to the culture. Our office is just outside the walls of the old city of San Juan. And I mean old, like 400-500 years. None of this piddly 100 year modernistic stuff. Ponce de Leon is buried here folks. Now that's old.

The old walled city has tiny curving streets, 3 to 4 story villas with balconies projecting over the streets and probably interior garden courts protected from the street. Paving is a cobblestone type of bluish stone, supposedly carried as ballast on the Spanish galleons and then cut up and used to pave the streets. A bit uneven and rough to walk on but lasts the ages. The houses are reminiscent of the French Quarter in New Orleans with the grillwork on the balconies, but without the long windows and doors. To me, walking down the streets is like being in the old city section of Milan around the Brera, or possibly Paris.

The cafes (cafes with an accented e in Italian) are there too. Open coffee bars with stools and a few tables where you take your coffee, or whatever, and talk and watch the world go by. Or you can get your pastelillas and have your lunch at the same time (pastry pockets stuffed with cheese, chicken or something indiscernible). From experience I have learned that the local coffee is not an espresso equivalent. Adding sugar alone does not really make it palatable. One should add hot milk just like the locals. (My espresso from Chicago is still my preferred coffee, from this little cafe we know of.)

The food is an interesting mixture of Puerto Rican native, Caribbean vegetables and fruit and adaptations of Spanish staples such as rice. The plantain is ever present: sliced, baked, mashed, rebaked, stuffed, probably mashed and schlepped too. The only way I like it is a bit roasted and served on the side like cooked bananas. Plantain chips (yup, sold in potato chip bags) are not the Caribbean's answer to Pringles. But the rice dishes are very good. Vegetarians could probably go wild here. Then there is the seafood, for the occasional extravagant dinner. Fresh oysters, shrimp, Caribbean lobster (kind of like crayfish) are all available, and claws too. The Caribe Hilton offers an exceptional seafood buffet that I have indulged in twice. Both times I think I ate 15+ fresh oysters, and not much else, except shrimp and the coconut ice cream.

Coconuts everywhere. Not served many ways, though. I don't know why. There is a coconut drink that Joa and I love which is like coconut milk and sugar and that is it. Not sure how much nutritive value it has but it tastes terrific. And the coconut ice cream/sherbet is wonderful. There are local candy bars made from coconut, without or with molasses, brown sugar, etc.; the regular ones look like an Almond Joy bar without the almonds or chocolate. Taste okay too.

Drive down any of these roads and you are in for an amusement park thrill. The drivers are very flexible, speedy and competent. Even if you don't know how to keep out of the way, they will drive around you. Um, traffic laws, signals and lanes are taken with a good amount of salt here. You are never too late to turn off into that exit lane you think you might have missed. Everyone, almost, has a police-siren-fake to vent their frustrations with. Hey, this is quite an equalitarian society; everyman has the same power as the police to hurry traffic, everyone is important and has somewhere urgent to be, so everyone has a siren. Of course, that means that everyone just sits and sirens at each other, but that is ok because life is like that and we have tomorrow as well, too.

I told you it was just like Italy. Flexible, accomodating, friendly. Just don't try to accomplish too much in a hurry, or in too straightforward a manner. Relax, enjoy life, watch your wallet, have a good time and don't rush; life is like that.

A few geographic notes. This is an island with mountains and coastal plains, i a tropical zone. Temperatures probably range in the 70-90's all year; maybe 80-90s. Trade winds blow along the northern coast; the southern coast is much drier, hotter and less windy with less ocean wave movement. The land's profile is still rugged, not much erosion of mountains seems to have occurred. Then again these are volcanic rocks which may not erode quickly. Everything, just about, is covered with verdant foliage. Even the mountains, with their abrupt shapes, strange rounded forms or odd angles, are covered with a green drapery of thick vines, undergrowth, ferns, and various trees. An open lot in a city block is a primeval forest in the making, a piece of ground yearning to return to its primitive roots. Joa said if you spit on the ground here, a plant will grow overnight, but in Chicago it would just freeze. Flowers bloom in gaudy dressing just like tropical fish in the water. All this life and greenery makes one redefine the possibility or rationality of control and order in life and one's surroundings.

El Yunque is a rare national forest for the U.S. It is a tropical rain forest, here on the east of the island. It is a mountainous area, climbing into the clouds, with bird, frog and plant life that is unique. No, this is like the Amazon; no crocodiles, alligators (I never keep them straight), no Katharine Hepburns on rafts, no 3 foot wingspan butterflies. But it is beautiful...forests just lush with moisture. Ferns growing everywhere and taller than you'd believe. Lizards scuttling along (or maybe that's only in the city, not in the cool forest). Waterfalls running merrily down, swirling around and over the rocks they've pulled down over the centuries. Cool mountain streams, frigid in comparison to the warm waters of the trade currents on the northern shore. A land where you could possibly survive by just walking through the forest every day collecting fallen coconuts. Eden must have been like this: verdant, abundant, growing so easily and pleasing so well.

And there is a land in-between the mountains and the coast. Very rolling hills, fertile valleys similar to the dairy region in Switzerland in the foothills of the Alps. With the mountains off in the distance at the end of the valley, a truly beautiful sight. Perhaps a bit more peaceful, quiet, subtle than the contrast between sea and shore, mountain and cloud. A bit homier. But awe-inspiring too, like the great dairy valley and moving fertile hills of the Spring Green countryside in Wisconsin. These hills however, will never feel snow.

Even out in the country the style is still Latin, Mediterranean. Lots of people have houses, albeit concrete on raised stilts, with metal louvers instead of windows; but it is probably the right kind of shelter for this climate. Lots of hanging out...in your front yard, in the road, next to your or your buddy's car. Passing the time, not much where to go, but watch it all go by. Be flexible, accomodate yourself to fate and life is like that.

Mailing Cts on A/T 50

TOC Good stuff...I really like the format. Try moving the total page number box to lighten up the clutter.

DP&SW Speaking of missing steps and other disappearing historical artifacts: years ago, I belonged to a local preservation group in Dearborn, Mich. whose aim was to preserve a wildlife conservation area around the Henry Ford mansion, Fairlane, on the estate's grounds. Ford Motor Co. was strongly opposed to the conservation efforts because the land was prime development site for the Fairlane shopping center, condominiums, etc. However, Ford had specified in his will that the mansion and grounds were to be preserved, etc. During the development, the historic carriage house to the mansion was "oh-so-sorry-mistakenly" demolished by the construction concern who were putting up the condos, etc. The Michigan historical societies, etc. got very upset, but what could they do? Anyway, the group was trying to preserve a belt of greenway that linked the parkland in the area. Without the strip of connecting woods, wildlife in the area would be cut off into isolated oasis pockets. After years of court battles, the state took an interest in the case and eventually FoMoCo was found to be at fault. Actually, it was the Ford Development Corp., not FoMoCo specifically. Land was set aside for preservation, and the other development continued. However, the mansion is used as a conference/office site by the U-M Dearborn and is still reasonably maintained, so far as I know. But the carriage house was never reconstructed nor were damages paid to any historic commission.//Congrats to Dave!

John In a similar, yet strange vein re yr waking up & eyeglasses: my mother will occasionally claim that she can't hear what you're saying if she doesn't have her glasses on. Could be that she is making up visually for hindered hearing, or else she can't focus her aural attention until she has a visual focus first.

Bonnie I know it's probably futile, knowing Sam, Andy and even you, but why? Why buy that van that's been hibernating out in NM and try and convince the darned thing that it masochistically really wanted to return to the damp and snow of the rustbelt from the nice dry desert? Why not a nice new Golf-type like Andy's? Actually this question is more for Sam than you.//San Juan is older than Santa Fe. But it's notin the continental U.S.//Re transmission fluid: oh gawd. Remember that cute trick about adding fluid if you ever drive an automatic stick VW. Works wonders.//Keith was taken care of, you know, for a wonderfully magic time there, short as it may have been. (In March, 1987.) Now maybe he'll believe in his terrific self all on his own; but I hope not too much.

Hugh You were at the Lovell's? *WOW* How are they? How is LaGrange or LG Park wherever they live? Is Endicott turning out to be a heartbreaker like Bob? They live so close, but yet so far away from me. Our circles don't cross at all...

Barry I'll take you on a tour of almost anywhere you want to go...Chicago, Detroit, San Juan, Milan. Just bring your wit and your delightful company. You going to come to Chicago finally just as we are leaving?

Roxanne Take good care of yourself. Scott should also take care too. I am very sorry at the uproar in your lives. I hope you both find the answers to what you are looking for, separately if not jointly.//I know that this is life and all, but I am very saddened at the dissolutions occurring among my friends in GT. Somehow everyone seems more special than the rest of the world and I can only hope we endure in our shared companionship and joy in spite of hard reality.

Steve Speaking of Woody Allen, what do you think of Radio Days? I need to see both that and Hannah.

David Have you ever been to Ashland for their festival? A friend's parents retired up there and I heard it's lovely.//I like yr format.

Donna Please see my last ct Roxanne.//Gee, I never anticipated really living at Isher, but with the mail forwarding Joa & I have arranged with you & Tullio, 530 W. Walnut will seem a second home.

Roxanne My comment got in earlier, out of sequence.

Guy Yr excuse is no excuse when you are a guest in someone else's home. But again, I was merely suggesting a discussion point, not judging. Perhaps we need to be aware of all domestic duties at Isher as well as children duties.

Marty Paper is a lousy medium for a tremendous hug, but you get one anyway. When I read yr zine it sounded so much like you that I got terribly Kazoosick for yr company. Nice to see you in print again, and still around eh? My best to the rest of the gang at 535.

GoM to it! story Barry & Bill: lauds, laughs and hugs. I laughed myself sick while reading it at midnight and probably made the neighbors here in San Juan think I had a terrific lover around or something.//For any and all who care: the great restuarant/dive in Chicago for charbroiled goodies is called Charcoal Delights and it's in the phone book. Thanks for the hint, Sam.

Kirin If you don't mind I would like to give your list to some non-fannish friends who live in the area. Nice review job.

Rod Yes, if you have a regimen of exercise, etc. by all means continue. I never got into physical exercise much and really should, only it is as difficult to start as they have always said, sweaty Cher commercials for health clubs or no sweaty Cher commercials.

Well folks this is it. This is a new format since it's too late to get the dittoes to Greg, and I want to minimize page space. It's back to ditto for next month in Kazoo.

Take good care and my very fondest regards.

For informational purposes only

Valli M. Hoski

San Juan assignment

APARTMENT	Postal address:	Villas del Mar, No. 7F-Este Carretera 187 IV Isla Verde, Puerto Rico 00913
	Location:	Villas del Mar, No. 8L-Oeste (809) 726-3157
OFFICE	Postal address:	Booz, Allen & Hamilton, Inc. Departamento de Hacienda, Rm. 213 Apartado S-4515 San Juan, Puerto Rico 00905
	Location:	Departamento de Hacienda Booz, Allen & Hamilton, Inc. Edificio Intendente Ramirez Parada #1 San Juan, Puerto Rico 00905-4515 (809) 791-0603 (809) 721-2020, extension 2292

JUST WHAT I NEEDED
TO FILL THIS PAGE

Gregory Ruffa
10380 Maya Linda Rd., Apt. C-303
San Diego, Calif. 92126
(619)-695-8647

* * *

No allegedly witty titles or obscure quotations this month, since I have to get on to other things. I'm going back East for the last week of this month and there's a lot to be disposed of by then. The next 'zine may get done on my father's new laserwriter while I'm home (who am I to buck the latest hi-tech trend in this APA?).

Not much new is going on at work, which is to say the Crystal Palace folks just wasted another month. I'm re-running results on performance that I had already finished, until they switched to yet another new design (and a new name: the Air Force now calls this thing the Advanced Launch System or ALS; those familiar with medical terminology will find this an unfortunate choice of abbreviation). The DoD and NASA have finally agreed on what they want and the formal announcement for research and development is out; our proposal is due in about six weeks. We will presumably then get a contract to study a design for the thing for a year. Next summer, someone will get money to go build the thing and fly in by 1993; if that ain't use, this division is in **BIG** trouble. I was told this week that Prudential-Bache analysts give Space Systems Division about a 10% chance of surviving another year. Really makes ya anxious ta stick around...

I was indeed in Washington, D.C. at the end of April for the AIAA Annual Meeting and the session of the national technical committee on space sciences and astronomy. The annual meeting seems mostly for the benefit of managers and marketing people. I'd planned to go to some of the talks, but they were all non-technical and introductory in nature. Instead I wandered through the exhibit hall and talked to a number of the exhibitors (including the American businesspeople selling Proton and Russian launch services for Glavkosmos). I couldn't very well pick up brochures for everybody, but I did get you one souvenir, included in this issue. My committee meeting ran from ten to a quarter of six and still didn't get to everything on this agenda; we are mostly concerned with promoting the space scientists' and astronomers' desires within the aerospace industry and to the government. I am on the steering subcommittee, chaired by Wendell Mendell, to plan what the committee should do for the next five years. I will also be writing the article reviewing the year's activities in astronomy and space science for **Aerospace America**.

I have started to make arrangements to go to Westercon and have already bought a plane ticket to the Bay Area. Could someone please send me information on the convention, so I know where to show up? Is anyone looking for a roommate? Meanwhile, I have applied for the usual two quads at Phoenix and am offering space to attendees there; I'll have one room starting Wednesday night and both on Thursday; I will be staying on into Tuesday, so let me know if you are similarly inclined. I've an idea for a side-trip: you all sing about it, so why not **go** there? Would anyone like to see Benson? It's maybe two hours away and I have no idea what's there, but if **your** heart longs to be there, let me know...

I'm appending news from the Mars Underground and an item related to Hugh's Challenge. I've also a ton of frankings from the last two months -- I'm polling you to let me know if I should keep running this stuff. See you again shortly.

MAILING COMMENTS

APA-TECH 49

(continued)

Guy of the East Youthful enthusiasm about space is all very well, but will it last when these kids find out how hard it all really is and have to pay for it out of their **own** pockets? Is a future in space where they'll make their financial commitment? How many of our own generation, who grew up in the exciting milieu of Glenn in orbit and men on the Moon, are out buying condos at ski resorts and crabbing about their taxes? A Gallup poll from last year indicated that a majority of Americans favored continued and increased space activity, but were against paying more taxes to do it.

Yoicks! In your winter sky section -- Regulus is in **Leo**, not Orion. That **should** be "Rigel." You might also single out Procyon for attention, since it's easily as bright as some of the other stars mentioned. Putting all those stars together forms what is informally known as the "Winter Hexagon." What I've seen of your book so far looks pretty good; I really like the presentation of both finder and main 'scope views.

Bill Orgh! Another Bentley-initiated project -- that boy sure has a penchant for drawing people into stuff. Make sure you get a nice, **BIG** contribution out of him! If a Chicago **Pyro** does get rolling, let me know and I'll try to send something.

Your comment to Jamie about overstriking a double quote for a dieresis mark just illustrates the adage that you can't make an umlaut without backing an em...

I've seen misuse of "it's" to denote the possessive cropping up disturbingly often now. I've noticed it in a few "respectable" newsmagazines and, most recently, on a display card at the San Diego Museum of Art. Given the way language works, I expect it will **become** the "correct" form around 2010.

Your folks' '61 Corvair sounds like my father's first car, a '37 Chevy he reconstituted himself after the war. It had a hole-in-the-floor problem, too, causing rain-water to splash on my mother-to-be's shoes. One day, he was going over some railroad tracks when he heard something go **BADDOOM!**, followed by the sound of something being dragged along under the car. He lifted the floor flap to espy his battery bouncing along, towed by its cables. He hoisted it up onto the seat beside him and there it remained for some time.

Annette It is too bad that Bill Leininger has tumbled out of the APA again, as he might well have had some remarks to share on books dealing with solid geometry. A couple I have which you didn't mention (or didn't get to yet) are **Polyhedra Primer** by Peter and Susan Pearce (Van Nostrand Reinhold, 1978) and **The Geometrical Foundation of Natural Structure: A Source Book of Design** by Robert Williams (Dover Publications, 1979).

I think the problem is not that mathematics is scorned by the art world (a few centuries ago, it was considered **essential!**), but that the arts and humanities attract college students who can't hack math (whether through personal disinclination or the typical array of inept teachers). This is also the fault of our compartmentalized approach to education which treats science, art, philosophy, religion, and other aspects of human culture as if they were utterly disjoint.

Rod The reason you haven't heard anyone mentioning the use of F-1 and J-2 engines isn't because they didn't investigate the possibility. The surviving specimens of these engines are not in good enough shape any more to use without considerable work. (The display engines are useless, except as decorations, because they have not been maintained.) Refurbishment can cost nearly as much as building a new rocket engine from scratch, apparently. We (and, I suspect,

every other rocket maker) looked into reviving old F-1s and restarting the production line and determined that it would not pay. For the purpose of future designs, which is to reduce costs by an order of magnitude, the old Saturn engines simply are too expensive to build, refurbish, and maintain. Even the Shuttle Main Engine is being rejected from future applications for that reason.

I believe Orbital Sciences Corporation was awarded the Mars Observer contract back around 1985. It was "decreed" at the time by NASA that they would get that mission, so they could get a foothold in the upper-stage business. That's why you've never heard of "MOM" being considered as a Shuttle/Centaur or Titan/Centaur mission.

Nanotechnology is certainly one of the more bandied-about buzz words of recent times. I'd prefer that the touts cooled it a bit until they started demonstrating something more concrete.

I'm a bit resentful concerning the Amiga 2000. I've had my 1000 for a year now and am still trying to accomplish some of the things I bought it for when **Amiga-World** comes in the mail and says, "Hey, kids! Lookitthis!!" Well, I will just continue to upgrade my machine and will probably wait until 1990 or so to get something new.

Fractured Flickers was a Jay Ward-produced series using old silent movie footage and newly-made-up storylines (Henry Corden narrated, I believe). I think the studio did this around 1961, after finishing the original Rocky and Bullwinkle series. It was from this show that I learned who Ben Turpin was.

APA-TECH 50

Cover Sure must be an **APA-TECH** cover, all right: it's got a spaceship on it!

Valli Nice to see someone bucking the trend toward fully-justified, laser-written text -- now this **looks** like a fanzine! It's even got punched-through "O"s. Good luck in Old San Juan!

The Crystal City Metro stop was already in place back in 1983, when I flew down for Constellation. It was a fair walk from the hotel, but the Hyatt ran courtesy vans to it pretty often, so I did use it to go into town recently.

Susanrah Ginger beer used to be one of the beverages of choice in our circle back in Bexley Hall. A big Saturday night consisted of Guy and his roommates, a friend from across campus, and I sitting around playing cards, listening to the stereo, eating freshly-baked cake, and drinking Schweppes ginger beer or Vernor's or Chelmsford (a local brand) ginger ale. (Yeah, I know: typical Techmen...) I was pretty upset when the Schweppes was no longer available. More recently, I've seen Old Jamaican out there in Boston, which is also pretty good. Any of these make Canada Dry taste like... soda pop.

You mean those people don't offer you a loaf of bread for your calligraphy?!

John I can't comment well on your own experience, since my vision without glasses isn't too bad. But it seems one cannot discount the possibility that your increased level of consciousness is now a conditioned response to putting on your glasses, so that the act itself is what wakes you up. Clearly, further research remains to be done. (What a great excuse to lie about in bed!)

It is true that Atlas is being redesigned with a larger payload fairing. This winds up reducing payload capability by a few hundred pounds. (I sit down the aisle from the folks who are doing performance analysis on it. I am their in-house consultant on geosynchronous satellite stationkeeping.) When they say in **AvWeek** that it can accommodate Shuttle payloads, they mean geosynchronous satellites weighing up to 2500 pounds, which was a big part of the old Shuttle manifest. We presently have three outstanding proposals (GOES, Eutelsat, and Britsat) and no customers. (There was a little good news recently: Eutelsat said "no" to Proton.) Redesigning

Atlas by itself won't save us, in my opinion. In ten years, every spacefaring nation, except Brazil and India, will be launching Atlas-class and larger rockets.

Bonnie Andy moves his car by telekinesis? So that explains how he can do 85 in neutral! Sure saves wear on the engine...

I'm glad to hear they finally finished the RTA line to O'Hare. I'll have to give it a try next time I'm out there.

"Sam wanted flares in case the electrical system failed on the highway..." I have this picture of you leaning out the window and firing flares into the night sky to light your way.

I'm glad you and Sam made it all right and that you have overcome some of your driving fears.

Hugh Does this spacecraft you are asking about carry 100 kilograms of useful payload, or is that its total weight? If inert structure, guidance equipment, and maneuvering propellant have to come out of that, you're only going to have about ten to twenty kilos left for anything else.* If the payload is a hundred kilograms, the spacecraft could weigh three to five times as much. (The scaling isn't linear...) An interesting challenge, nonetheless, though it sounds like this would have to be pretty much a single-function spacecraft.

*Whoops, forgot about communications equipment -- that makes things worse.

Barry Another thing that's begun to bother me lately about ballistic missile defense. Let's suppose it's non-nuclear and works perfectly. What happens to all the fissionable material that used to be **inside** the warheads? In the case of a major attempted assault, how much of that stuff is released into the environment? Certainly there isn't as much radioactivity as there would be if the attack succeeded, but... Just one more nasty aspect of having nuclear weapons around in the first place.

Actually, if you, Bill, Jamie, and I all talked about your week in California, it would be more like **Ran**. As Alice would have said (but kindly refrained), "Kurosawa and Kurosawa..."

Your corollary to Clarke's Third Law exploits the principle that the contrapositive of a proposition ("not q implies not p") have the same truth value as the proposition itself ("p implies q"). By this same relentless logic, one can derive such statements as this: "If I haven't told you a million times, I've never told you at all!" Isn't Aristotlean logic **marvellous**? ("Logic is wreath of pretty flowers that smells **bad**!")

The Third Law suggests to me an industrial-park-style corporation (located in some place like Bedford, Mass. or Sunnyvale, Calif.) bearing the name Sufficiently Advanced Technology. I can almost see the letterhead now...

That's pretty good, Johnny, but that ain't the way I heard it! As I recall the NPR piece on highway driving, some listener wrote in and said it was **New Jersey** drivers who regarded signalling as giving information to the enemy. The point is academic now, in any case, since the practice has become universal...

I promise if I come out to East Lansing and stay at your place, we'll talk about nothing but eyeballs and retinal chemistry...

You'll us Japanese-speakers a thing or two show, eh? And to think we used to get on so well together... (*Ee, Doitsugo mo yomimasu.*)

It is true that SDI only deals with delivery of nuclear weapons by ballistic missiles. To try to handle bombers and cruise missiles calls for another, less-publicized program called the Atmospheric Defense Initiative (ADI). At present, this is another amorphous, somewhat less expensive system or set of systems. No one is sure how big it will be or how much it will cost, since we're not sure how large and diverse the threat is from these avenues.

Since you're curious about my epigraphs, I'll identify the sources for you. Rolf is correct in saying that some of them are from songs, and Dr. Guy caught me out immediately as pinching lyrics from the Talking Heads. (I like to quote passages from popular culture out of context...) So saying, the *Urtexts* are:

in AT 45, epigraph -- "Heaven," **Fear of Music** (1979)

AT 47, title -- Donald Fagen, "I.G.Y.," **The Nightfly** (1982)
epigraph -- "The Book I Read," **Talking Heads '77** (1977)

AT 50, title -- Bullwinkle J. Moose (Jay Ward) (c. 1960)
epigraph -- Jane Wagner and Lily Tomlin, **The Search for Intelligent Life in the Universe** (1985)

Sorry ya asked?

I kinda like that no-grownups-policy idea. ("Naughty gr'ups! Bonk, bonk on the head!!")

Steve Animated cartoon fans really like that particular "Calvin and Hobbes." I put a copy of it in my 'zine for **APATOONS**, only to discover it had already appeared there a couple issues earlier.

What does a Talking Snoopy sound like, considering he expresses himself exclusively in thought balloons in the strip and in dog-sounds in animation?

The thing I came to dislike about Trivial Pursuit (and programs like "G.E. College Bowl") is the reduction of significant knowledge to interesting tidbits. The other problem is that many of their answers are incomplete or just plain wrong. (Yet another turned up when I played with Bill Hartkopf and another faculty person in the Astronomy Department at Georgia State. The "Science" category contains a large number of astronomy questions. Should I be pleased that my field is regarded as grist for the trivia mill?)

The Chicago APAs deal with the "joke" issue by ending the sentence in question with "(hhok)." I must admit that I found this abbreviation far more impenetrable than "in re yr ct."

LaserDaveTM I quite agree with your analysis of colorization. I saw a couple minutes of the Turnerized "Forty-second Street" (about all I could stand) and felt like I was watching an ancient, washed-out color print of a film. A really decent job probably would cost far more than it would be worth.

Your demonstration comparing East Asia with the U.S. can only be carried so far. In countries like the Phillipines, people who work in factories are happy to have jobs making money, considering the alternatives. Further, by local standards, the wages they get look pretty good. This, though, hardly condones the fact that they still do pretty badly in proportion to the amount they contribute to the company's financial success.

The long-range plans for space transportation that we're are looking at run out to the year 2020, in fact. Some of the stuff related to lunar and Martian colonization looks ahead to 2035. (I'm highly skeptical of such schedules, given our erratic funding scheme...) As for my personal life, I don't know yet where I'll be next **year**, although the plan doesn't include being **here**!

Well, I finally **did** get that first credit card, after tying a nice block of money to a one-year CD. The one is plenty for me and if I use it once a month, that'll be a lot. I guess I'm just old-fashioned, but I prefer working in cash, where I can **see** how fast the money is passing through my hands...

Donna As I understand it, the operational definition of being on the GT Mob List was being a person who sent in postage stamps to Jeff Duntemann and filled out the questionnaire. Your proposal seems quite in keeping with accepted tradition.

I'm sure that if "Shalmaneser" had been misspelled, GTB would have been pounced upon back around AT #2. I didn't get around to **reading** the novel myself until about #35.

I hope you are taking precautions while refilling those toner cartridges, such as wearing gloves and a mask. I think the jury is still out, but there is some evidence that the toner materials are carcinogenic. (You should be especially careful if you're planning to have a child -- or perhaps should stop doing that altogether.)

Roxanne I extend to you the same condolences I did to Sam. I feel very badly for you and Scott. I hope you will find something that will make you happier in your life.

OK, I'll try not to be slighted that you didn't write comments to me because my 'zine was the last. It's all right... no, really... (@&%\$*! Next time, it goes up front!!)

Guy of the North I am controlling myself, more or less, as far as the video is concerned. I watch maybe a few hours a week, mostly movies. It still seems like a lot, though, when you start multiplying that by 52 weeks per year. (And I suspect I also have several thousand hours of childhood TV under my scalp...)

We will now, of course, expect several amusing applications of high-temperature superconductivity to be shown off at Ishercon X.

Marty Nice to hear from you, if only once in a while. There are at least a couple of arrangements of rocket engines you could use, depending on whether you want pulsed or continuous thrust. But I fear you really won't accomplish anything this way. Even if you took Saturn-V first stages and planted 'em tails-up into the ground, you would only get about 7,000,000 pounds of thrust per rocket. The mass of Earth is $13 \cdot 10^{24}$ pounds, so the acceleration you'll get is only $5.3 \cdot 10^{-19}$ g or $5.2 \cdot 10^{-18}$ m/sec²; this is less* than the acceleration of the Earth's motion caused by the Sun, the Moon, or **any** of the known planets. It turns out that we can't even do much of a job deflecting small asteroids with the rockets we have right now.

* by at least seven orders of magnitude!

Bill & Barry Show This is just the sort of trip journal I enjoy seeing here and have come to miss for some time. I won't spoil it with my snide remarks (or corrections of fact)...

I was amused by the misspelling of Bill Chana's name; apparently, this happens to him quite a bit. After giving a talk at one of the AIAA meetings here, we decided to commemorate this. We gave him plaques with both variants of his name, the misspelled one first, of course...

Kiran Dr. Forward can be fun to listen to (and is certainly one of our more flamboyant physicists). But one must be careful to put his ideas into a real-world setting, as he is not one to worry himself with engineering (or sometimes even astronomical) "details." Antimatter propulsion sounds wonderful, until you calculate how much it costs to produce the nanogram or so a year that we do make. (How you would improve our production efficiency by a factor of at least a billion is a "detail.") Flying a "starwisp" at 0.1 c is exciting, until you have to concern yourself with high-speed impacts from interstellar dust grains. (Building the multi-gigawatt maser on Mercury and operating it effectively are more "details.") I get a bit discouraged with visionaries because they are so imaginative when it comes to big ideas, but not when it comes to dealing with all the problems imposed by living in the actual physical universe. I prefer hearing from people who will trouble themselves to do both (and, believe me, it's a lot of trouble -- if it weren't, we'd be gods by now...)

The "physical fallacy" is a new one on me; I can't say I've ever heard anyone seriously propose it. The "animistic fallacy" is, on the other hand, at the heart of many myths and religions (and much bad science).

The problem with past great performances not getting onto CDs (yet) is essentially the same one that has arisen every other time we've shifted to another new recording medium. I'm sure people were appalled when Caruso didn't make the transition right away from acoustically-recorded shellac to electrically-recorded plastic (I'm not sure what they used between shellac and vinyl...). Ol' Enrico is available now, through digital enhancement of the best surviving contemporaneous recordings. We've been through cylinders, disks, reel-to-reel tape, eight-track cartridges, cassettes, microcassettes, laserdiscs, acoustical, electrical, electronic, 78s, 45s, 16s, 33s, hi-fi, LPs, stereo, quadrophonic... It makes no commercial sense to transfer **everything** through every medium change; the recording companies just wait and see which earlier stuff people still clamor for. The Beatles only just made it to CD for the first time a couple months ago. Classical performances from the pre-LP era have steadily made it over to disc and tape. New performances always turn up first in the new medium. I'm sure Walter and Furtwangler and Schnabel and Horowitz and many of the great pre-CD artists will reach the modern catalog. Have patience!

Rod

We'll have to wait for the analysis on the Atlas' guidance computer to see how much NASA takes the rap for. On the other hand, it looks like this will make Canaveral finally get the decent meteorological equipment they've been wanting.

The latest development with the Mars Observer is beginning to look like true Fletcherean idiocy. Orbital Sciences offered to **buy** a Titan for a 1990 launch and have NASA pay them back later; NASA is falling back on a technical excuse that tosses things at Congress. Maybe another letter is called for...

Your comment on colorization is well taken. Esthetic choices in a black-and-white composition can differ greatly from those for color. Many films **today** are shot in black-and-white by the director's decision, and not simply to save money.

I no longer worry about parents who want to put tight restrictions upon their childrens' education, as long as they keep their tiny-minded views within their own tiny community. I feel sorry for their children, though, if they ever happen out into some other part of the world...

I will agree that "bureaucratic paranoia" does run wild at times in the classification of information. We have one document at GD with an extended introduction to the theory of orbital mechanics with the word "**SECRET**" printed at the top of every page. (It's silly, but it does lend a certain cachet to being an astrophysicist...) Guy's point is still valid, however: huge, "black" programs tend to lie down upon and crush whole fields of study by choking off the exchange of information among professionals.

Ah, I'm always amused by the proposal that we dump radioactive waste into the Sun. To do this would entail killing off the Earth's orbital velocity and putting the payload on a straight radial infall trajectory, whereupon it would reach the Sun in about 65 days. The velocity change required would be 29,786 m/sec for the Earth's orbital velocity plus, say, another 3200 m/sec to break out of low Earth orbit. (I'm not even worrying about the booster here, just the upper stage.) Using the rocket equation and taking the specific impulse of a Centaur to be 450 seconds (only a little generous), we get a ratio of mass before ignition to that after the burn of 1763. Allowing for the fact that the engine weighs **something** leaves **no** weight **at all** for payload; this plan is out of the question for chemical rockets. It becomes possible for vehicles with ion propulsion, but would require very expensive systems for disposing of waste at any reasonable rate. I would think that, after Challenger and Chernobyl, you would have a difficult time getting approval for launching large amounts of radioactive material in any case.

FIRST ANNUAL
UTAH STATE UNIVERSITY
**CONFERENCE
ON
SMALL SATELLITES**

- APPLICATIONS
- SYSTEM CONCEPTS
- SUBSYSTEM DESIGNS/TRADEOFFS
- MISSION DESIGN
- PERFORMANCE/COST/COMPLEXITY
- COMMERCIAL OPPORTUNITIES
- LAUNCH OPPORTUNITIES

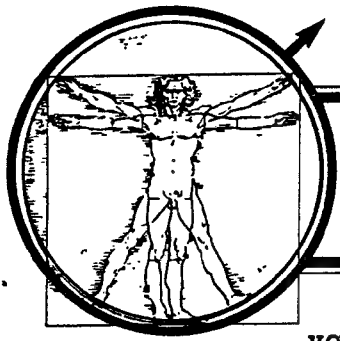
COSPONSORED
BY
UTAH STATE UNIVERSITY
AIAA / UTAH SECTION

OCTOBER 7-9, 1987
UTAH STATE UNIVERSITY
LOGAN, UTAH

ABSTRACTS DUE BY JULY 15, 1987

ABSTRACTS/INFO:

CONFERENCE ON SMALL SATELLITES
UTAH STATE UNIVERSITY
LOGAN, UT 84322-4140



Mars Underground News

VOLUME I, NUMBER 1

WINTER 1987

WHAT IS THE MARS UNDERGROUND?

The Mars Underground is a closely knit but loosely woven network of people representing government, private industry and individuals. It has one major goal: landing humans on the Red Planet, Mars.

The name "Mars Underground" originated in 1981 at the first Case for Mars conference in Boulder, Colorado. It was coined by Leonard David, former editor of Space World (now editor of this newsletter), who was also instrumental in suggesting the Case for Mars conference. The conference was organized by a group of University of Colorado graduate students and others.

The Case for Mars arose out of the deep concern that for 10 years NASA had had NO program to study human missions to Mars. The conference brought together the widespread work already done by scientists, engineers and others who still held the goal of someday reaching Mars. Since the Case for Mars, the Mars Underground has grown, and new research on Mars has begun. The Planetary Society formed its Mars Institute and has provided major support to the Boulder group to continue a series of Case for Mars conferences. (The third will be held this summer.)

The Mars Underground is not a formal organization and people are members by virtue of their advocacy and efforts in research and education to advance the cause of Mars exploration and settlement.

Welcome to the Mars Underground News

This newsletter will provide a communications channel for scientists and others interested in the exploration and eventual settlement of Mars. Our objective is to report individual projects, programs, trends, political activities and speculative opinion regarding the broadening of humanity's reach to the fourth planet from the Sun. On the pages of the newsletter we will review the research of people actively working on human and robotic exploration of Mars.

The Mars Underground News will begin publishing at a rate of four times per year. It is brought to you through the courtesy of The Planetary Society. Readers are encouraged to submit material to the editor for possible use in the newsletter.--Editor

NASA TRIES TO DELAY MARS OBSERVER

On January 2, 1987, NASA Administrator James Fletcher notified Congress of his plan to delay launch of the Mars Observer, the only approved US mission to the Red Planet, from 1990 to 1992. His stated reason was that there is no room on the space shuttle manifest for a 1990 launch.

The Planetary Society strongly ob-

jected to this move. Noting that an existing Titan 34D expendable launch vehicle could be used, and that all relevant NASA advisory committees were urging the agency to return to a mixed fleet of launchers, Society officers wrote Dr. Fletcher, Congress and the Department of State. The Society also asked its members to contact Dr. Fletcher and Congress. At press time,

they had sent over 20,000 letters and telegrams, and congressional staffers estimated that every congressman had received at least one letter on the Mars Observer from a Planetary Society member.

NASA did say that it would consider using the Titan 34D if Congress asked it to do so, and if Congress would provide the money. Rep. Edward Boland (D-MA), House Appropriations Subcommittee Chairman, suggested that the Mars Observer be given the shuttle slot reserved for Ulysses, the European solar-polar mission. When NASA rejected this idea as an unnecessary slap at the Europeans, Boland washed his hands of the matter, rejected the Titan 34D proposal and told NASA to delay the Mars Observer.

Fortunately, others in Congress took a position in favor of a 1990 launch of the Mars Observer. Senator Spark Matsunaga (D-HI), Representative George Brown (D-CA), and Representative Bill Nelson (D-FL), Chairman of the House Subcommittee on Science and Technology, asked NASA not to delay the mission.

As we go to press, this issue is unresolved. The Planetary Society is preparing public testimony and news briefings on the Mars Observer and urges all interested persons to contact NASA and their congressmen. A Mars Observer Fact Sheet and additional information is available from the Society, 65 N. Catalina Ave., Pasadena, CA 91106.

--Louis D. Friedman

MARS SCAN

DOWN BY THE MARTIAN SEA? Scientists at the Jet Propulsion Laboratory, poring over Viking imagery, recently suggested that Mars may once have had lakes or seas of water. The JPL team suggest that, in high-resolution photographs, they can identify features resembling islands, sandbars and shorelines. Cydonia Mensae, in Mars' northern hemisphere, Deuteronilus Mensae, an eroded mesa on the margin of the northern lowlands, and the eroded crater in Acidalia Planitia, are sites of the possible features.

ALGAE ECOLOGY Oleg Gazenko, Director of the USSR Public Health Ministry's Insti-

tute of Medical-Biological Problems, recently provided an overview of space biology work in his country. He said that space ecology research is being directed toward developing biological life-support systems for spaceships and orbiting complexes, and that such a system can be developed in 15-20 years. One proposal being considered for long-duration travel, noted Gazenko, is based on algae that can regenerate 100 percent of the oxygen necessary for a crew.

VESTA A combined study of Mars and small bodies of the solar system is now being planned for 1992 or 1994, based on French-Soviet cooperation in Project Vesta. As now blueprinted, two Soviet boosters with nearly identical hardware will rocket spacecraft to Mars. Soviet-built entry probes--balloons carrying cameras--will be deposited on the planet. The balloons will traverse large regions of Mars, descending occasionally to take surface measurements. Two French-designed vehicles may also be sent past Mars to fly by a comet and asteroids, and to deposit a penetrator or a lander on an asteroid.

BRITISH-SOVIET AGREEMENT Soviet scientists attached to the Phobos mission to Mars may soon be rubbing elbows with British counterparts. Roy Gibson, Director General of the British National Space Center, signed an agreement in Moscow for integrating British and Soviet science teams during the planning of the Mars venture.

The Mars Underground News is published by The Planetary Society four times a year.

Editor: Leonard David

Publisher: Charlene Anderson

Technical Advisor: Christopher McKay

Direct correspondence to:

Leonard David, Editor

Mars Underground News

PO Box 23883

Washington, DC 20026-3883

For information about The Planetary Society, write:

The Planetary Society,

65 N. Catalina Ave.

Pasadena, CA 91106

MEDICAL GO-AHEAD NEEDED At the October 1986 conference of the International Astronautical Federation in Innsbruck, Austria, cosmonaut Valeriy Ryumin, who has spent more time in space than any other human (362 days over three journeys), was asked about Soviet interest in human flight to Mars. He explained that there is "no direct preparation for Mars," adding that, given a medical green light, preparation for the trek would begin. Ryumin concluded that human travel to Mars is "too expensive for the richest country" and that "the optimal approach is to get all the countries together to attain this goal."

US/SOVIET SPACE COOPERATION

The Reykjavik meeting of Ronald Reagan and Mikhail Gorbachev has led to a new space pact that could result in joint robotic and human exploration of Mars.

Both countries are reviewing a broad agenda of cooperative civilian space research, which could be signed in early 1987. The five areas of agreement are: Earth science; solar-terrestrial physics; astronomy and astrophysics; planetary exploration; and biology and medicine.

While no joint human space projects, such as the 1975 Apollo/Soyuz Test Project, are outlined in the preliminary agreements, some 16 programs to coordinate projects and exchange data have been suggested. Programs under discussion include:

- Placing US investigators on the Soviet Phobos mission science team and Soviet scientists on the US Mars Observer team;
- Using the US Deep Space Network to help receive signals from Soviet spacecraft;
- Exchanging medical data on cosmonauts and astronauts, and Soviet bioscience research. Such data is very useful for identifying medical problems associated with long-term spaceflight.

Yet to be determined is the prospect of a cooperative US/Soviet automated sample return mission. Advocated at high levels in the Soviet Union, the concept is falling on deaf ears in the United States. Why? The US does not have, as yet an approved Mars program

for robotic exploration, either by sample return or a rover. For many, the collaborative sample return program could provide the catalyst for an international human sojourn to the planet early in the next century.

SOVIET PHOBOS MISSION DETAILED

Momentum is gathering for the Soviet Union's two Mars-bound Phobos spacecraft, set for launch in July 1988 aboard Proton launch vehicles. The dual flights will mark a new generation of modular interplanetary probes, with later versions to be sent to comets and asteroids.

Both probes are scheduled to reach the Red Planet in 200 days, then begin a complex series of delicate maneuvers, enabling the vehicles to hover over Phobos. The spacecraft would rendezvous with the moon at a height ranging from 100 to 260 feet.

For 15 to 20 minutes, onboard equipment, including television, will measure the mass and isotopic composition of Phobos' regolith (the surface soil layer) and determine the body's topography, surface texture, electrophysical, spectral and polarization characteristics. Images of the surface are expected to reveal details a few inches across.

A small, onboard laser, called "Lima-D," will focus its beam on Phobos, vaporizing surface specimens, thereby creating tiny charged particles. The ionized matter will be drawn into a chamber with a special accelerator, where the material's mass spectrum and, therefore, its composition, can be determined. About 150 laser pulses are planned.

While these remote observations are enhancing our knowledge of Phobos, two landers will make direct contact. One lander is an immobile, long-lived, automated station. It will carry out several radio experiments and measure seismic noises generated by thermal stresses and Mars' gravity. Meteorite impacts will also be monitored.

A second lander will hop across Phobos. Using a set of rods and a pusher, the probe can move about the uneven terrain in up to 60-foot jumps. At

perhaps 10 sites, an x-ray instrument, a penetrometer, a magnetometer and gravimeter will measure surface and near-surface structure, mass and local gravitational anomalies.

On all counts, the Soviet Phobos project is a bold, innovative and exciting investigation. According to mission planners, the 1988 project represents a "logical continuation of investigating small bodies in the solar system begun with studies of Halley's Comet."

CASE FOR MARS III A CALL FOR PAPERS

The Case for Mars III: Strategies for Exploration will be held July 18-22, 1987 in Boulder, Colorado. The Planetary Society will be one of the sponsors. As with the 1981 and 1984 conferences, the meeting will include workshops, panel discussions and a public day.

The 1987 program is dedicated to defining innovative national and international programs to explore Mars. It will include analysis and discussion of technological, scientific, social and policy strategies for robotic and human missions to Mars. Special emphasis for this year's conference is on international programs as a stimulant to future robotic and human exploration.

Submit papers, abstracts and participant names for consideration to:

Case for Mars III
PO Box 4877
Boulder, Colorado 80306
303/494-8144

TECHNICAL NOTES

JOINT US/USSR ROVER-SAMPLE RETURN

Several ideas and issues have been identified concerning a joint US/USSR rover-sample return mission to Mars. In one concept, the US would build the rover and the USSR the sample return craft. They would be launched independently to rendezvous on Mars. Other "divisions of labor" are being considered.

The rover would travel to scientifically interesting sites, collect samples, and deposit them in the sample return vehicle. It would also take measurements to characterize the environment from which the samples were

taken, possibly involving drilling, scraping or digging. The return vehicle would then take the samples to Earth.

The rover and return vehicle would rendezvous only on Mars, thus minimizing any concerns over technology transfer and greatly reduces engineering interfaces. Reliability and political concerns may require that the rover and sample return vehicle both be capable of independent missions.

Site selection is a challenge. The rover's landing vehicle must be able to survive the range of obstacles in the landing footprint. Once it has landed, the rover must be able to reach areas of scientific interest. So, the selected site must be smooth enough that the craft can land, while still being close to an interesting area.

Once the sample has been collected, the return vehicle will land and rendezvous with the rover. The return to Earth raises problems, such as the temperature changes that may alter the sample, and the sterilization or quarantine in an Earth-orbiting facility. The samples could be picked up from an orbiting space station, or returned directly through Earth's atmosphere.--
Christopher McKay

THE REFERENCE SHELF

"Soviets in Space--Are They Ahead?", an excellent article in the October 1986 National Geographic. It provides an extensive overview of the Soviet Union's space program, including possible missions to Mars. Cost: \$1.90. Contact: National Geographic Society, 17th and M Streets, NW, Washington, DC 20036.

Manned Mars Missions (NASA M001 May 1986) summarizes papers presented at Marshall Space Flight Center on reasons for going to Mars and mission concepts. Cost: Free. Contact: Michael Duke, NASA/Johnson Space Center, Houston, TX 77058.

An Explorer's Guide to Mars provides a map, illustrations and information that a future explorer might need to visit the Red Planet. Cost: \$4.00. Contact: The Planetary Society, 65 N. Catalina Ave., Pasadena, CA 91106.

AMORPHOUS ABSTRACTIONS

by: Guy Wicker

Things are still active on the superconductivity front. On April 18 ECD made 125 Kelvin superconductors. We have magnets floating in open air over slabs of the stuff, and I have a little Meissner effect demonstration on a plastic tray in my kitchen. I feed it liquid nitrogen from a coffee thermos and a little magnet floats on air long after the nitrogen has boiled away. ECD has thin films, but they're not good enough to make Josephson junctions. Stanford and IBM have films now too, so it's a tough race to see who can make logic first. I hope to demonstrate thin film Josephson devices before the next APA is due.

The only problem I'm having is that I'm not actually working for ECD now, I'm working for their subsidiary company OIS. The director of OIS has absolutely forbidden me from even thinking about superconductivity because I work for him 100 percent of the time. Actually, I've never signed any agreement with OIS except for the backs of my paychecks, so I still consider myself to be an ECD employee. So I sneak in at night to work for ECD. They really need an EE working on this. At one point some of the physicists thought they had achieved superconductivity at above room temperature and were putting their samples in ovens to determine when the superconductivity stopped. Hours before they were going to call the press to make the announcement, I checked over the measurement apparatus and found the error. You can never trust a physicist to make an electrical measurement.

Minicon was lots of fun. It is the one con at which the PFRC shows up in massive quantities, so I know as many people there as at a worldcon. Also, since it is held on Easter weekend, it is a 3 day con, making it even more like a worldcon. Ishercon is a little like worldcon too.

Dayton was disappointing to me. I spent most of my effort looking for Macintosh parts and found none. If I had been looking harder for test equipment and IBM computer parts it would have been a great success. The one significant thing I found was a really small 7/8 inch diameter by 5 inch long laser tube. Tullio has it and will be making me a "magic wand" which is not a weapon. Cons don't usually have a wand policy.

MAILING COMMENTS

John - At IBM Yorktown there is a research project called GF11 which is making the largest computer switch in the world. It is called the "Memphis" switch, named after the Federal Express delivery system.

Laserdave - The reason for colorization, as explained to me by Lee Hart,
↓ Rod is to get around copyrights. Colorization is a significant "improvement" and may stand up in court as a way to defeat the copyright on any black and white movie.

Bonnie - 50 inches of snow in one night is even a lot by Houghton standards.

Barry - Unproven amorphous speculations are my job! I take umbrage at that statement and hereby challenge you to a duel of honor. Time bombs at 50 paces!

Steve - Nuclear Monopoly is a real game, invented by Chris Cloutier with the help of the Ann Arbor game club. It is a very fun, playable and well balanced game. You use the cards from both games with some additional CHANCE and COMMUNITY CHEST cards like: Win Nobel peace prize. Collect \$100; Nuclear plant disaster. Pay electric company \$100; Heavy water experiment. Pay water company \$50; Diplomatic coup. Receive one million population from each player. If someone gets a whole set of properties they can choose to build houses or silos. If someone has a hotel on Boardwalk, you simply nuke it to avoid payment. It becomes a crater and is skipped over for the remainder of the game.

Kiran - A whole bunch of people in GT got the Blue Angel mailing. How do they know what we do at Ishercon?

Greg, Guy - Would either of you like to invest in an observatory? ECD is selling the McMath - Hulbert Solar Observatory on the McMath estate. It has a 7000 sq. foot main building complete with a machine shop floor, two darkrooms, and lots of lab space on the first floor. The second floor has offices and could be easily converted into a great living space for 3 or 4 people. It has a 30 by 50 foot library with a projection booth, a 35mm and 16 mm projector. There is a 65 pound iron-nickel meteor on the stairwell. the 3 towers contain a 10.5 inch reflector, a 24 inch Cassegrain, and a 22 inch two mirror coelostat. All of these are set up for solar observation. It has an underground laboratory, a 50 foot long vacuum chamber, and every nook contains some strange apparatus. It is equipped to take motion pictures of the sun and has hundreds of 35 mm reels of material. It has 10 acres of land and a 3 bedroom house on the grounds. And it only costs \$250,000! This is too much for me to afford, but it is the ideal techie dwelling and if you'll both contribute you can feel free to use it anytime.

...Gathered up by Greg Ruffa

this cutaway drawing, which was presented by NASA to Congress last month. The crew would live and sleep in this area.

One factor endangering effective execution of U.S. space goals is the growing turf battles between NASA and other

First U.S. Commercial Sales Of ELVs Expected in 1987

By Theresa M. Foley

Washington—U.S. commercial expendable launch vehicle companies are expected to make their first sales in 1987, due in large part to U.S. government policies that have changed since the 1986 Challenger accident, while other space-based commercial businesses will make extremely limited progress because they have little or no access to space.

McDonnell Douglas Astronautics official Charles Ordahl recently lamented the fate of the Payload Assist Module program—a commercial space project the company started in 1977 that still has not broken into the black—before a roomful of space supporters attending a Colorado Springs space conference.

The Payload Assist Module project has not been able to turn a profit, in part because of the recent policy shifts by the U.S. government that will prevent most commercial PAM buyers from using the space shuttle, Ordahl told his panel. For commercial space projects to succeed, "a constant, steady government policy must be maintained," Ordahl said.

NASA Administrator James C. Fletcher, also on the panel, said that while he agreed consistent government policy was needed, companies should not "count on a consistent policy because administrations change."

"So my question to you," Fletcher said to Ordahl, "is what is the future of the commercialization of space?" Despite a strong push to encourage space commercialization by the Reagan Administration during the last four years, the answer to Fletcher's question is not clear.

More than a year after the Challenger accident, most commercial space ventures based on the shuttle remain at a standstill. They have a year or more to wait before the shuttle will be available to carry their payloads into space once again. They have a 7-10-year wait before they will be able to use the space station. Projects depending on these two NASA programs are not likely to make much progress during the coming year.

NASA's Office of Commercial Programs has turned its emphasis toward terrestrial spin-offs of space technology and other ground-based work, such as increased use of sounding rockets and parabolic aircraft flights to attain short periods of microgravity for materials processing work. Isaac Gilliam, NASA's assistant administrator for commercial programs, said NASA is starting to get results from the Centers for Commercial Development of Space that it began funding two years ago.



First-stage liquid oxygen tank of Delta 181, which will fly an SDI mission later in 1987, is being mated by McDonnell Douglas technicians in Huntington Beach, Calif. A stretched version of the Delta will serve as the Air Force medium launch vehicle and be marketed to commercial satellite owners for use in launching communications satellites to geostationary orbit.

commercial and science users has not been established.

Prospects for space manufacturing to become a business have "been put on the back burner, or possibly in the chuck wagon," James Samuels, director of research for the Canadian investment banking firm McLeod Young Weir, Inc., said. Instead, space business profits in the next 5-10 years are expected to come primarily from space transportation and manufacturing of hardware for systems such as the space station. For the foreseeable future, he expects the government, not the private sector, to continue to be the primary user of space.

U.S. commercial space transportation companies are expected to pose a serious challenge to foreign launch companies and announce their first sales in 1987. The prospects for U.S. commercial ELV sales have increased greatly over the last few months as a result of U.S. government orders for Deltas and Titans that will keep those production lines running.

Courtney Stadd, the newly appointed director of the Commercial Space Transportation Office of the Transportation Dept., said, "I see every evidence that we have at least two booster manufacturers in

AVIATION WEEK & SPACE TECHNOLOGY/March 9, 1987 113

■ Mission 36—Defense Dept. geosynchronous orbit payload.

The space station is facing even greater general program challenges than the shuttle. Both NASA and contractor officials have said the station's management structure remains too immature to handle station development, and that it will take at least another year for the management challenges to be brought under control. Cost estimates for the baseline station have grown substantially, from \$8 billion originally to about \$15 billion today.

NASA space station director Andrew J. Stofan said that even under the \$8-billion plan, the program could expect peak funding needs of about \$3 billion by the early 1990s—a considerable portion of NASA's budget.

Under the latest cost estimates, those peak years would be even higher. Stofan is more concerned about the impact of individual peak-year funding on station decision-making than the entire cost estimate spread over many years.

The Reagan Administration remains strongly supportive of the station program but is unwilling to swallow a near doubling of the cost target.

Senior Administration officials listed delay of station, deferral of station capability and outright cancellation of the program as their options. Delay of the station and deferral of major capability have received support, with no formidable advocacy building for cancellation.

Initial station development would be slower first launch of chief elements and initial manning of the facility is not expected for eight or nine years. Once manned, the vehicle will be more constrained in its operations for a longer period. It will remain as a small module cluster connected to a single transverse beam for a longer time before growing ultimately to a dual-keel configuration.

Addition of the European Space Agency and Japanese modules and some Canadian-built servicing capability will increase the utility of the station, if the foreign partners agree to the new U.S. station position presented in February.

Under those guidelines, the station could be used for U.S. Defense science and technology needs—work on military space applications that concern Europe, Japan and Canada.

The U.S. also has formulated a more strict interpretation of how the foreign modules would be used, based on comparing the multibillion-dollar U.S. contribution with about \$1.5 billion expected from both Japan and ESA.

Japan and ESA will be able to use their modules only half the time, and could not use the U.S. modules at all under the new guidelines. Canada would be entitled to 3% access for its contribution. The foreign partners will decide later this year whether the provisions are acceptable.

flights following the accident is relatively stable, and will introduce a consistency in operations to help the program get back on track.

The large number of Navstar satellites booked on the shuttle after the first 10 missions, however, could be changed if the U.S. Air Force transfers some of them to McDonnell Douglas Delta 2 expendables. But the shuttle payload mix for flights 26-36, into about early 1990, should remain stable. They include:

■ Mission 26—Tracking and Data Relay Satellite, TDRS-C, for relay of both civilian and military satellite data.

■ Mission 27—Defense Dept. geosynchronous orbit payload involving either a National Security Agency Midgetman electronic intelligence satellite, U.S. Air Force/TRW, Inc. missile warning satellite or two USAF/General Electric Defense Satellite Communications System, DSCS-3, spacecraft.

■ Mission 28—Central Intelligence Agency/USAF imaging reconnaissance satellite.

■ Mission 29—TDRS-D relay satellite.

■ Mission 30—Hubble Space Telescope scope.

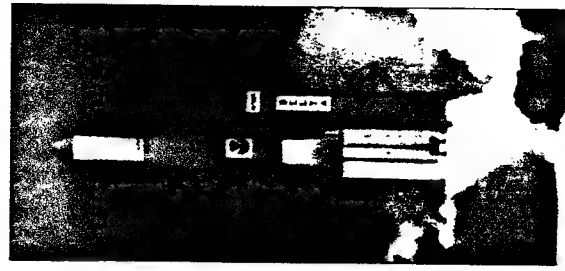
■ Mission 31—ASTRO-1 ultraviolet telescope group, which will remain attached to the shuttle.

■ Mission 32—Defense Dept. geosynchronous orbit payload.

■ Mission 33—Magellan Venus radar mapper.

■ Mission 34—Strategic Defense Initiative Spacelab mission.

■ Mission 35—Two USAF Navstar satellites and a materials science payload.



agencies involved in space. Many agency managers believe the outcome of disputes over expendable booster planning, shuttle payload selection and Defense involvement are critical to the long-term outlook of the space agency.

NASA managers are critical of what they characterize as White House, congressional, Defense, Transportation and Commerce department meddling in space affairs traditionally governed under NASA; managers in the other agencies believe NASA's criticism is unwarranted. Officials from the other agencies said NASA has not been flexible in accepting overall national policy on space.

Stable Space Affairs

The forecast is for more stable civil space affairs in three to five years. By that time, policy issues should be settled, an aggressive expendable launch effort should be under way and the space shuttle should be reasserting itself as an important element of U.S. space operations.

The Reagan Administration will be replaced in the White House by that time. How this will affect space efforts could depend largely on whether a Republican or Democrat is elected President. Both the space station and military space operations such as the Strategic Defense Initiative are expected to be viewed less favorably under a Democratic administration.

By the early 1980s, the space shuttle should be flying about a dozen missions per year. This will be only half of its predicted flight rate prior to the Challenger accident—but still double the annual number of manned missions that the U.S. achieved during peak years in the Gemini and Apollo programs.

Major elements of the shuttle plan, such as use of the extensive shuttle launch facilities at Vandenberg AFB, will remain in limbo, however.

Another issue the shuttle will confront will be conservative operational practices throughout the program in light of the Challenger accident. This will have the effect of reducing shuttle payload weight, making expendable boosters more competitive in tradeoffs between the two launch systems, although weight restrictions are expected to be eased as more shuttle missions are flown successfully.

It is likely that conservatism will result in more launch delays as managers focus on many specific issues, such as weather conditions, minor system anomalies and unfinished documentation.

The outlook for the first 10 shuttle

GOESH weather satellite was launched Feb. 26 from Cape Canaveral on a Delta vehicle (AVAST Mar. 2, p. 29). The satellite will be renamed GOES-7 and will replace GOES-5, which lost its ability to transmit pictures of cloud cover patterns nearly three years ago.

Defense Dept. Developing Range Of Launch Vehicle Concepts

By Bruce A. Smith

Los Angeles—The Defense Dept. is developing a wide range of launch vehicle alternatives to compensate for the present lack of space shuttle capability, provide assured access to space in the late 1980s and develop a system for placing large Strategic Defense Initiative payloads in orbit during the 1990s.

The initiatives vary from design and

launch Navstar and commercial spacecraft.

- Heavy-lift launch vehicle (HLV) for Strategic Defense Initiative payloads.
- Titan 4 to duplicate shuttle payload capabilities.
- Upper stage system for the space shuttle to duplicate Titan 4 capabilities.
- Titan 2 program to place smaller payloads into high inclination orbits.
- Recovery of the Titan 34D program.

Li. Gen. Aloysius G. Casey, commander of Air Force's Space Div. here, said, however, that while there are broad initiatives on expendable programs, it is important not to exclude the space shuttle as a key part of the Defense Dept.'s long-term launch capability.

"If we believe in access to space, it works both ways," Casey said. "If you have a heavy payload you want to get into high orbit, and we have some difficulty with the Titan 4, then the shuttle is the only game in town."

"Frankly, I think that we ought not to go in such a rush to go [with] expendables that we ignore the capabilities of the shuttle," he added. "On the other hand, we have so many missions that require the shuttle stacked up, that we have to be very careful in the near term about adding anything to shuttle traffic."

The Air Force is beginning the proposed heavy-lift vehicle program and plans to announce the project formally this month. The program will begin with preliminary studies by several contractors.

Draft versions of the program research and development announcement (PRDA) call for an initial launch capability of 100,000-lb. payloads and a flight demonstration of the vehicle in 1993. The initial version would be followed by designs for increased cost savings during later, faster-paced launches, possibly through the return and reuse of propulsion and avionics systems.

USAF/Martin Marietta Titan 4—scheduled for initial launch in October, 1988—is designed to be capable of placing a payload of 10,000 lb. into geosynchronous orbit or 39,000 lb. into low Earth orbit. The Titan 4 was designed to duplicate both the payload weight and size capability of the space shuttle.

development of an entirely new class of booster to enhance present designs and the conversion of decommissioned missiles to space launch vehicles.

Because of the urgent need for launch resources, as well as the major payload weight and operational cost changes envisioned, the Air Force has altered the way it deals with industry on some of the new projects.

In addition, Defense Dept. and industry are forging new agreements for use of USAF launch and range facilities by commercial operators. The programs include:

- Medium launch vehicle (MLV) to

Initial contractors could be continued on the program until preliminary design review, when the number of participants could be reduced, depending on funds available. The Strategic Defense Initiative Organization made a supplemental budget request for heavy-lift vehicle development, but initial HLV studies would be made with SDO funds already available.

USAF's Space Div. is forming a cadre program office in preparation for start of the program.

The National Aeronautics and Space Administration also is interested in heavy-lift capability and is working with the Defense Dept. on requirements. NASA has studied a draft version of the Air Force's HLV program research and development announcement.

Potential Civil Requirements

Richard H. Truly, NASA associate administrator for space flight, said the space agency is looking at potential civil space program requirements for heavy lift—such as space station and possible large planetary spacecraft—and that NASA is participating with the Defense Dept. in a joint study on a national heavy-lift capability.

"NASA has capabilities, particularly in heavy lift—Saturn and shuttle experience—that the nation cannot afford not to use," Truly said. "There is no argument in the Defense Dept. about that. We haven't worked out roles and missions, but I am convinced that there will never be a heavy-lift vehicle... unless it is a national vehicle."

The PRDA would be used for the Air Force's initial announcement of the heavy-lift vehicle to encourage contractors to consider a variety of designs and concepts. Air Force officials would initially like to cut costs by two-thirds.

Launch Pad Time

Casey said some savings may come from decreasing the amount of time and activity that is typically conducted on the launch pad prior to satellite launch. Some of that work could be carried out in-plant or in an off-line facility by instituting changes in design or operations approach.

"There are other steps that we could take that would allow us to really shorten the time on the pad and therefore the engineering teams surrounding the booster as it gets ready for launch," he said. In addition to SDO, Casey said there are programs—such as wide area surveillance and command and control in support of operational commanders—that

Development of a heavy-lift launch vehicle by the Strategic Defense Initiative for launch of payloads in the 150,000-lb. range also could have commercial implications. Defense Dept. HLV supporters believe it is needed for military, civilian and commercial launch services.

However, Stadd noted that a large, multiple-payload launcher may not make sense for commercial users. "The physical and engineering may be able to configure a vehicle that has capacity of that kind. But the insurance and financial people involved in risk management would be horrified to put all that payload on one vehicle," he said.

He said finance and insurance officials

passes the largest number of launches but the "least documentable."

The size of the market for communications satellite launches is expected to be moderate, with less than 20 satellites requiring launch services each year, according to most estimates. The Transportation Dept. projects that 12-16 payloads will need commercial launch services each year, based on ELV industry estimates and the Battelle annual payload forecast that is funded by NASA.

The market for ELVs is expected to be healthy for the next few years because of current requirements combined with the backlog that has developed while the shuttle and Ariane were grounded. Samuels

warned that the market may be overestimated in the long range as a result of the heavy near-term demand. Therefore, as many as six companies may be involved in commercial launches over the next few years, but once the backlog is worked off, those ranks will thin, he said.

Stadd believes commercial ELV demand will be augmented over the next few years by government demand for commercial launch services. He said it is very important for government to begin contracting directly for commercial services.

The biggest government launch service users are NASA and the Air Force, but both of those organizations always have managed their own launch programs.

NASA's space station program could create a substantial demand for ELV services in the 1990s, although NASA does not have a policy to use ELVs for the station. The proposed international agreement that will govern the station program identifies the space shuttle as the baseline transportation system for the station, but states that other launch systems belonging to the partners can be used if they are compatible with the station.

Many space experts believe that as the station program matures during the next few years, NASA will incorporate the use of ELVs to resupply the station and possibly for other missions associated with the deployment of station hardware.

USAF/Martin Marietta Titan 4—scheduled for initial launch in October, 1988—is designed to be capable of placing a payload of 10,000 lb. into geosynchronous orbit or 39,000 lb. into low Earth orbit. The Titan 4 was designed to duplicate both the payload weight and size capability of the space shuttle.

development of an entirely new class of booster to enhance present designs and the conversion of decommissioned missiles to space launch vehicles.

Because of the urgent need for launch resources, as well as the major payload weight and operational cost changes envisioned, the Air Force has altered the way it deals with industry on some of the new projects.

In addition, Defense Dept. and industry are forging new agreements for use of USAF launch and range facilities by commercial operators. The programs include:

- Medium launch vehicle (MLV) to

Initial contractors could be continued on the program until preliminary design review, when the number of participants could be reduced, depending on funds available. The Strategic Defense Initiative Organization made a supplemental budget request for heavy-lift vehicle development, but initial HLV studies would be made with SDO funds already available.

USAF's Space Div. is forming a cadre program office in preparation for start of the program.

The National Aeronautics and Space Administration also is interested in heavy-lift capability and is working with the Defense Dept. on requirements. NASA has studied a draft version of the Air Force's HLV program research and development announcement.

Potential Civil Requirements

Richard H. Truly, NASA associate administrator for space flight, said the space agency is looking at potential civil space program requirements for heavy lift—such as space station and possible large planetary spacecraft—and that NASA is participating with the Defense Dept. in a joint study on a national heavy-lift capability.

"NASA has capabilities, particularly in heavy lift—Saturn and shuttle experience—that the nation cannot afford not to use," Truly said. "There is no argument in the Defense Dept. about that. We haven't worked out roles and missions, but I am convinced that there will never be a heavy-lift vehicle... unless it is a national vehicle."

The PRDA would be used for the Air Force's initial announcement of the heavy-lift vehicle to encourage contractors to consider a variety of designs and concepts. Air Force officials would initially like to cut costs by two-thirds.

Launch Pad Time

this country that are ready and willing to go after satellite business." Stadd said he believes there will be sufficient demand to sustain at least two large ELV companies in the U.S. and at least one entrepreneurial rocket company selling small payload launchers.

McDonnell Douglas' Delta 2 may be the strongest competitor for medium-size communications satellites by virtue of its selection as the Air Force medium launch vehicle. McDonnell Douglas is expected to offer a commercial version of Delta 2 capable of lifting about 4,000 lb. to geostationary transfer orbit for about \$35 million.

Third-Stage Delay

Delta 2 is expected to be cost competitive with European, Chinese and Soviet launch vehicles. The continuing troubles that ArianeSpace is experiencing in qualifying its redesigned third stage for flight, and ensuring scheduled delays, could help commercial sales of Delta 2.

Martin Marietta also is expected to continue its commercial Titan sales effort. Although Martin lost the MLV contract, it does have government contracts for Titan 4s and Titan 2s. The company also has a good chance of receiving additional orders for Titan 3s from the Air Force to launch NASA missions, including a Tracking and Data Relay Satellite and the Mars Observer.

General Dynamics' prospects for commercial Atlas/Centaur sales are slimmer than Titan and Delta because General Dynamics has not won any new government contracts to keep production going. However, the company is expected to compete this year for a three-vehicle contract to launch National Oceanic and Atmospheric Administration weather satellites that are in the Atlas/Centaur weight class. If General Dynamics wins, it may have another shot at the commercial market.

The market for small launchers, capable of boosting 300-3,000 lb. to low Earth orbit, is expected to show the first real signs of life in 1987. Two companies—Space Services, Inc., and American Rocket Co.—are competing for early contracts to launch small payloads for NASA, the Defense Dept. and commercial users.

There has been virtually no commercial market for small payloads to date, but several government and private commercial space officials predict this market will rapidly grow in the next few years.

Samuels estimated this market is worth \$300-500 million or more over the next three to five years. He said development of the market will take no longer than will making the vehicles available, because the Air Force has 15-20 small satellites "in a warehouse somewhere ready and waiting for launch." He would not further identify the payloads, but said the size of this market is deceptive because it encom-

pass the largest number of launches but the "least documentable."

114 AVIATION WEEK & SPACE TECHNOLOGY/March 9, 1987



Martin Marietta is producing Titan 34D launch vehicles for the Air Force and modifying and refurbishing Titan 2 missiles for use as space launch vehicles at its facilities near Denver, Colo. Martin also is developing the Titan 4 booster, which has been designed to duplicate space shuttle payload weight and size capabilities.

"should be brought into the briefing room" with government launch planners so that commercial problems associated with HLV will be recognized by its designers. The lack of understanding of low launcher commercial needs, as demonstrated by the HLV, is a good example of the "disconnect" that exists between the commercial and government communities on space transportation, he said.

Even if the HLV is not viable for commercial users, HLV research is likely to yield propulsion advances that could benefit the private ELV industry. □

USAF/Martin Marietta Titan 4—scheduled for initial launch in October, 1988—is designed to be capable of placing a payload of 10,000 lb. into geosynchronous orbit or 39,000 lb. into low Earth orbit. The Titan 4 was designed to duplicate both the payload weight and size capability of the space shuttle.

development of an entirely new class of booster to enhance present designs and the conversion of decommissioned missiles to space launch vehicles.

Because of the urgent need for launch resources, as well as the major payload weight and operational cost changes envisioned, the Air Force has altered the way it deals with industry on some of the new projects.

In addition, Defense Dept. and industry are forging new agreements for use of USAF launch and range facilities by commercial operators. The programs include:

- Medium launch vehicle (MLV) to

Initial contractors could be continued on the program until preliminary design review, when the number of participants could be reduced, depending on funds available. The Strategic Defense Initiative Organization made a supplemental budget request for heavy-lift vehicle development, but initial HLV studies would be made with SDO funds already available.

Science Funding Steady Despite Limited Flights

Washington—U.S. spending on space science and applications will continue at the rate of about \$1.5 billion annually for the next five years, but U.S. scientists will continue to face "serious difficulties" because of the small number of U.S. space flights dedicated to science for the rest of the decade.

The next large U.S. science project, the Hubble Space Telescope, is scheduled to fly on the space shuttle in November, 1988, but is not likely to be launched until about mid-1989 because the shuttle schedule is expected to slip by at least six months. At the same time, the Soviet Union, Japan and Europe will continue significant space science achievements, surpassing U.S. leadership in some areas.

"Other nations now have capabilities in space and Earth science research that equal, or in some cases, surpass those of the U.S.," Louis Lanzerotti, chairman of the Space and Earth Science Advisory Committee to the National Aeronautics and Space Administration, told a Senate panel recently. The U.S. lead in space science "has eroded, and in some areas the lead has been lost," Andrew P. Nagy, a University of Michigan space scientist, said.

Two reports issued in 1986 by U.S. scientists warned that the U.S. was losing its preeminence in space science to the Soviet Union and other countries.

Navy Orders Mirror For Sea Lite Program

Paris—The U.S. Navy has ordered a second and lightweight high-energy laser beam expander mirror from France's Recherches et Etudes d'Optique et de Sciences Connexes (REOSC) as a follow-on to a similar mirror delivered in 1984 for use in the Navy's Sea Lite program.

The \$980,000 contract is for production of a 2-meter (6.56 ft.) diameter aspherical primary mirror assembly machined from a solid blank of ceramic glass.

REOSC's first contract was signed with the Navy in 1982 for a mirror to serve as a spare for the Hughes Aircraft Co.'s Sea Lite experimental pointing and tracking system, which was developed for use with a high-energy laser beam. The 1982 order, valued at \$920,000, was part of the Navy's evaluation of less costly (laser) techniques for such mirrors (ENR/July 19, 1982, p. 153). REOSC delivered the first unit in October, 1984 (ENR/June 3, 1985, p. 343).

would be feasible if access to space could be made more economical.

The PRDA will give contractors the greatest possible latitude by including a general work statement of the goal rather than specifying certain characteristics of the vehicle. Contractors will provide their own work statements and cost estimates.

A similar approach was used for the new medium launch vehicle program—won by McDonnell Douglas—primarily as a result of the need to launch the entire constellation of Navstar global positioning system (GPS) spacecraft as quickly as possible. The Navstar satellites, in production at Rockwell International satellite systems division, were to be launched on the shuttle beginning last January.

Plans now call for McDonnell Douglas to launch the first MLV in October, 1988. The company expects to have a launch capability of 12 boosters per year by 1990, with a possible increase to 18 per year by 1991. Launch vehicles in excess of those required to launch Navstars could be used for commercial payloads.

MLV bidders were given launch requirements for the Navstar constellation instead of detailed vehicle specifications, followed by contracts for integration of the spacecraft with the booster and launch support. Bidders were allowed to propose the number of boosters that could be fit into the available budget for the first two years of the program, which resulted in greater proposal diversity than otherwise would have been possible. The contract includes launch services that should enable McDonnell Douglas to plan more efficiently for launch support operations.

Cassey said all of the final bidders betted Air Force targets for completing the constellation. "The proof of that, of course, will be putting the satellites in orbit," he added.

Commercial applicability also was a factor in selection of McDonnell Douglas. Factors such as launch costs, performance, potential market, and production and launch flexibility were taken into consideration during contractor selection. Cassey said Delta 2 was very cost-effective and allowed for wide commercial adaptation of the vehicle. Cost to launch was a major consideration in selection.

The Air Force is working on a second version of a model agreement for use of its launch facilities and ranges by companies for commercial launch activities. Cassey said the basic position of the Air Force is to charge commercial operators the same price other program operators within the government would be charged. Some companies, however, want the government to underwrite liability coverage and above the company's present coverage in the event of damages resulting from a launch problem. □



Technicians at Lockheed Missiles and Space facility in California transfer the Hubble Space Telescope from a clean room to an acoustic test chamber.

space science experiments from several nations. The Soviets soon will add a new astrophysics module to the Mir that includes experiments from the European Space Agency and individual space agencies of several European nations (ENR/ENR Feb. 16, p. 21).

Both Congress and NASA's space station task force on scientific uses have been critical of preparation to date. Brown said there is also concern that the station may not be as useful to scientists as possible.

"Fewer anticipated shuttle launches, reduced crew size and increased dependence on the shuttle are making scientists worry that the science on the space station will be greatly diminished," he said. The reduced shuttle launch rate for the future means that there will be fewer flights to perform preparatory space science work before the station is ready.

Eidelson said the two highest-priority missions that are candidates for new starts in Fiscal 1989 and 1990 are the Comet Rendezvous/Asteroid Flyby mission and the Advanced X-ray Astrophysics Facility (AXAF).

Both AXAF and another new start candidate, the Space Infrared Telescope Facility, are expected to be major science instruments that fly in formation with the space station.

The Comet Rendezvous/Asteroid Flyby mission, renamed Mariner-Tempel 2 in late 1986 after its intended cometary target, is the highest-priority new planetary and the solar spectrum, is scheduled for an early 1991 mission. □

planetary missions are the Lunar Geoscience Observer, a mission to map the moon and study its resources; the Near-Earth Asteroid Rendezvous observer, which would undertake a long-term encounter with an asteroid; and a Saturn Orbiter/Titan Probe, to study Saturn and probe the surface and atmosphere of Titan, Saturn's giant moon. The latter mission is under consideration as a possible NASA/European Space Agency cooperative project called Cassini.

More ambitious possible future science missions are the Mars Surface Sample Return and Comet Nucleus Sample Return. However, NASA will have a difficult time embarking on expensive new science projects over the next few years if the space budget is burdened with the \$1-billion added expense of keeping the grounded spacecraft healthy. If space science funding increased at the same rate as the overall NASA budget, the problem would be eased. However, space shuttle and space station have absorbed all the budget increases NASA received in Fiscal 1987-88.

NASA plans to use approximately one-third of the shuttle capacity to fly science missions in the 1990s. The new manifest included the following science missions, beginning in November, 1988, on the fifth shuttle mission following the resumption of flights:

- The Hubble Space Telescope launch is the next major U.S. space science mission, tentatively scheduled for shuttle flight 30 in November, 1988. The date is contingent upon the restart of shuttle missions in February, 1988, an event virtually certain to be delayed by at least several months.

- Astro 1, a Spacelab ultraviolet astronomy mission, is manifested as the sixth shuttle mission, 31, targeted for a January, 1989 launch.

- Two planetary launch opportunities are on the shuttle manifest in 1989, in April and November, and one in October, 1990. The Magellan mission to map Venus, the Galileo mission to Jupiter and the Ulysses solar polar mission will be assigned to fly in these slots.

- NASA plans to fly the Materials Science Lab, a payload bay rack that will carry materials for science experiments, on the shuttle twice in 1989 and once per year in 1990 and 1991.

- Two missions that would use the Spacelab pressurized module—Spacelab Life Sciences and an International Microgravity Lab—are manifested in late 1989 and 1990.

- The Gamma Ray Observatory, a large observatory, is scheduled for shuttle launch in early 1990.

- Atlas, a Spacelab globo/pallet mission to measure variations in the Sun's energy and the solar spectrum, is scheduled for an early 1991 mission. □

Edelson cautioned against undertaking a crash program for Mars exploration at the expense of other science programs that have been waiting in line for several years to get new-start approval. "A manned mission to Mars done cooperatively with the Russians is a wonderful goal. It would be healthy to have, with the understanding that it might be done in 30 years or so," Eidelson said. "But we don't want everybody to say, 'Forget everything else, let's go to Mars.'"

The U.S. could get started in the early 1990s on an interim program that would lead to manned Mars exploration via a Mars Sample Return Mission that could be accomplished within 15 years, Eidelson said.

selecting a Mars sample return as a national goal would give the space station a "direct function," because it would be needed as a staging area to assemble Mars sample return hardware that would need three or four launches to orbit.

U.S. science planning for use of the space station remains in the preliminary stages, while the Soviet space station Mir this year will host a wide array of major

programs of other nations. "The frustration felt by the space science community is resulting in the inability of the program to attract new, young researchers. The current space science projects are manned by aging scientists who are frustrated by the nation's inability to place dependable support behind the Office of Space Science and Applications and its projects," Brown said.

NASA's Fiscal 1988 budget request will keep space science spending at a flat rate of \$1.3 billion, but because of the overall 13% growth in the NASA budget, the percentage devoted to science will drop.

Edelson said the amount of money provided for space science is not enough to carry out a healthy program or to continue strong international space science leadership.

Pressing Requirements

The budget contains no money to buy expendable launch vehicles for space science projects, which is the most pressing requirement because of the space shuttle's problems. "You can't do space science unless you fly," Eidelson said. He has been one of NASA's most vocal advocates of the purchase of expendable launch vehicles for science missions, although neither Eidelson nor other senior NASA officials have been able to identify a source of funding for the rockets.

Edelson said seven science missions have been identified for transfer from the shuttle to ELVs, if funding can be obtained for the launchers. He is urging that NASA plan all future space science programs to use the most appropriate launch vehicle from the start of the program, rather than baselining all the missions on the shuttle. The space science office has recommended that the new Global Geoscience satellites, Wind, Polar and Geosail, be designed for ELV launch.

The Administration's Fiscal 1988 request lacked funds to continue the Advanced Communications Technology Satellite program or to keep the Mars Observer spacecraft on schedule for a 1990 launch. Congress is likely to direct NASA to restore money that was cut from those programs to keep them alive and on schedule.

"On the whole," according to Brown, "the Administration's 1988 budget request includes little that would alter the state of decline of our nation's space science effort."

Space science advocates are increasing numbers are calling for a Mars exploration program as a new national goal that

Europeans Confront Problems in Forming Long-Term Space Plan

Paris—Europe's effort to establish a coherent, long-term space plan is facing a range of challenges, including growing program costs, increased international competition on the launch service market and differences with the U.S. on the international space station.

The three main elements of Europe's coordinated space program—the increased lift Ariane launcher, participation in the U.S./international space station and the Hermes manned spaceplane—are expected to be presented for approval by European Space Agency member states this summer. The Ariane, Hermes and space station programs are grouped in a so-called package deal worked out among the key ESA countries.

The package will be submitted for approval at a European ministerial-level meeting that could take place in June.

"The behind-the-scenes work is in full swing to hammer out the package deal, but what is worrying us more and more is the spiraling costs of these programs," one West German government official said. "We're going to have to come to grips with this problem before it gets out of control."

The Ariane 5 is targeted to have a 5.8 metric ton (11,000 lb.) payload lift capacity into geostationary transfer orbit, and will provide a major capacity increase from the current Ariane 1-3 family and the new Ariane 4 that is expected to make its first flight in 1987.

Ariane 5 is designed to increase Europe's competitiveness in the international launch market and also will be used to orbit the French-designed Hermes manned spaceplane. Ariane 5 will carry one or more satellites on commercial missions, while the payload faring will be replaced by Hermes on manned launches.

Hermes is presenting Europe with new technical challenges. A plan to create, improve or restore some 15 European facilities to support the Hermes program has been approved by ESA. The first contracts under this plan are being allocated to the Swiss Federal Aircraft Factory in Emmen, Switzerland, and West Germany's Stuttgart University.

Other contracts are being prepared to fund the development of various spaceplane subsystems and ground facilities, and more than 250 industrial tenders have been submitted.

Prime contractor for Hermes is France's Aerospatiale and the French aircraft manufacturer Dassault-Breguet has been assigned prime contractor responsibility for Hermes aerodynamics. ESA has overall management responsibility for the

program. Under ESA authority, the French CNES space agency will oversee studies for Hermes and for certain directly related ground facilities.

Europe continues to review safety features for Hermes in the wake of the Challenger accident. A new Hermes safety advisory committee has been formed and held its first meeting in January. The committee is an independent body, and its role is to advise ESA and the French on all safety matters during the Hermes and Ariane 5 development.

The 10-person committee has representatives from ESA member states who are experienced in high-technology safety matters in such fields as aerospace, nuclear engineering and medicine. Chairman of the committee is Belgium's Pierre Goewarts, chief engineer of the nuclear safety sector at ASBL Vincotte, and retired Concorde test pilot Andre Turcat is vice president.

Separately, France is leading the effort to reestablish the Ariane launch schedule following the May, 1986, V18 failure. The next Ariane launch is not expected before May/June, representing a one-year grounding because of ignition problems in the third stage.

The 1986 accident led to redesign of the third-stage igniter and changes in the stage's operating parameters to insure a correct ignition under varying in-flight conditions.

Ground test firing is under way at Societe Europeenne de Propulsion facilities in France to verify the modifications and qualify a third stage for the V19 flight. Despite the V18 loss, Europe's Ariane space management/marketing organization signed 16 launch contracts in 1986 for a combined value of about 3.4 billion French francs (\$830 million)—nine of which were booked after the V18 failure. One reason for the large order volume was the change in commercial satellite launch policies for the space shuttle after the Challenger accident.

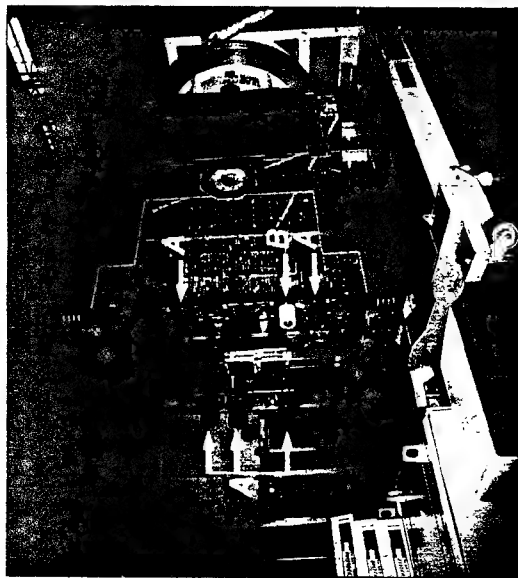
"Worldwide launch capacity is so strained that I don't think anyone can afford another failure. I don't think the market or the insurance companies could take such a blow," one Ariane program manager said.

Arianespace's orderbooks to date include 59 launch contracts, and its backlog is estimated at about 13.3 billion francs (\$2.1 billion). According to Arianespace, 29 of the orders are for European customers, while 11 are from the U.S.

European manufacturers are building 34 of the satellites to be launched by Ariane, while the remaining 25 are produced by American companies.

An additional 21 launch reservations have been signed by Arianespace, of which 18 are for non-European customers.

Arianespace will continue its marketing



TDF-1's air traveling wave tubes are visible in this photo taken at Aerospatiale's Cannes facility. Difficulties were encountered in developing the Thomson-CSF tubes, leading France to decide on using one tube from the company (8) and five from West Germany's AEG (A).

"We thought we were going to be able to work with the U.S., but we feel once again that the U.S. is a fair weather partner, and when things get tough, the non-U.S. elements are the first to be affected," the manager said.

ESA is increasing its overall budget level as the agency prepares to expand its activities with Ariane 5, Hermes and Columbus, as well as broaden its space science, microgravity and satellite communications efforts.

The agency's 1987 budget is set at \$1.5 billion, up from \$1 billion in 1985 and \$1.2 billion in 1986. Of the total, \$362 million is earmarked for space transportation activities—mainly Ariane and Hermes—while \$195 million will be spent on space station/space platform developments.

ESA's permanent staff also is growing, and is expected to increase from the 1986 level of 1,630 employees to about 1,850 by the end of 1987.

Europe continues to face a confused situation in the domain of TV broadcast satellites due to the number of international and national spacecraft systems now in development.

France is working to establish a degree of private funding for the TDF-1/2 high-power satellite program, and the French government has decided that if its conditions for financing are not met, the TDF-1 spacecraft alone will be launched and op-

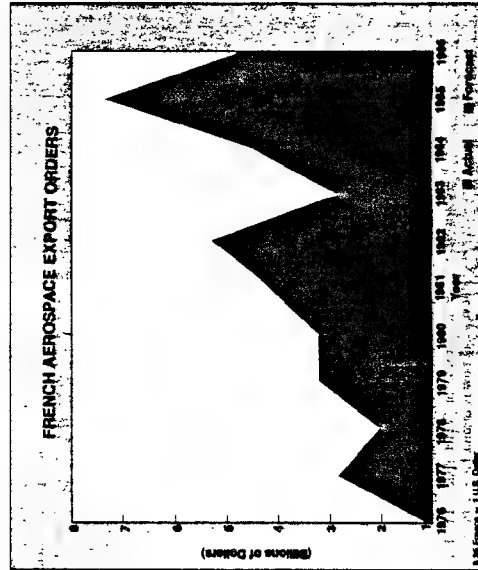
erated by the country's TDF broadcasting organization.

Production/assembly of TDF-1 has been completed, and a review board has declared the spacecraft flightworthy. The satellite will be readied for launch once the Ariane program is reestablished and a new flight schedule determined. TDF-2 is in the early stages of its integration.

Europe's Eutelsat multinational organization, which is composed of 26 European telecommunication/postal administration members, has taken a number of steps to consolidate its position in Europe's satellite telecommunications and TV broadcasting scene in face of the threat of competition.

Many of its actions have been taken to resist Luxembourg's efforts to use the Astra medium-powered TV broadcast satellite for the relay of television programs over much of Europe. In addition to its telecommunications, business service and telephone relay duties, Eutelsat satellites currently are being used to transmit television programs to medium-size ground stations for community/cable distribution. The organization is considering increasing its services to include direct broadcast satellites of its own.

One move to counter Astra was the Eutelsat decision to modify the design of its second-generation Eutelsat 2 series of spacecraft to enlarge the high-gain beam antenna service zone. The changes will provide an equivalent isotropically radiated power of 47.52 dbw, over a large part of Western Europe from the Iberian peninsula to Scandinavia, or from Italy to Iceland—depending on the satellite's geostationary longitude position. □



Soviet Union Takes Lead In Manned Space Operations

Washington—The Soviet space program has taken the lead over U.S. manned flight operations, and the USSR's rapid pace in unmanned launches and development threatens to overcome the West's technological lead in space.

Launch failures of the space shuttle, Titan, Delta and Ariane vehicles have allowed the Soviet space program to gain a greater advantage over Western operations than at any other time since the launch of Sputnik 1 in 1957.

The Soviets launched 91 space missions in 1986 carrying 114 payloads, somewhat lower totals than in previous years but still more than 90% of worldwide space operations, leaving 10% for the U.S., Europe, Japan and China combined.

The Soviet manned program represents the most viable challenge to Western space leadership. Since 1971 the Soviets have operated seven successful Salyut space stations with at least two dedicated to military objectives.

The new Mir space station is a major step toward fulfilling a long-term Soviet goal—development of a permanently manned station that can be substantially enlarged in space. Soviet cosmonauts Yuri Romanenko and Alexander Lavekin, on board Mir, are preparing to enlarge the vehicle during their mission, which will continue into late summer. Mir will be manned almost continuously.

The U.S./international space station, in

contrast, will not be able to provide similar capability for eight to nine years. Renunciation of NASA space shuttle operations in 1988 will provide the U.S. with formidable manned flight capabilities—especially in deploying large new Defense Dept. spacecraft. But this activity will lack the diversity of the Soviet manned program.

When the various elements of the Soviet space program are examined as a whole, they illustrate the depth of national commitment, budget support and industrial base the Soviets apply to their space effort.

The manned program alone has an extensive infrastructure and space launch capabilities, dwarfing U.S. operations. In addition to the Mir crew, the Soviets have committed to the launch of at least four large Proton boosters over the next four years to carry new modules to the station.

Module Development

Each of the modules represents a significant space vehicle development in its own right.

In addition to the modules, the Soviets will launch a Progress tanker/transport orbiter every two months to resupply the station. Each Progress mission represents a \$40-million space flight.

In U.S. terms, the Mir station, the module development and Progress resupply operations alone would represent a multibillion-dollar effort.

The Soviets have involved several dozen design bureaus and technical institutes in the USSR and Soviet bloc countries to develop research hardware and investigative programs for Mir—some of them military-related.

In addition to their manned activity, the Soviets have several other programs under development that also would be multibillion-dollar projects in the U.S. These include:

- An unmanned heavy-lift booster comparable to the Saturn 5 Moon rocket, which the U.S. scrapped after the Apollo/Skylab programs ended nearly 15 years ago. The Soviet booster will be able to place 200,000-lb. payloads in orbit; the first vehicle is on the launch pad at Tyuratam. First flight test of this SL-W booster is expected this year.
- A Soviet shuttle comparable to the U.S. space shuttle. The shuttle will provide the Soviets a flexibility in their space operations possible only with a large manned vehicle equipped with a payload bay. Payload for the Soviet shuttle is estimated at about 60,000 lb., which could be greater than the payload of the U.S. shuttle.

intelligence, electronic intelligence, ocean surveillance and navigation spacecraft as well as manned systems involving military activities.

A review of some Soviet mission areas during 1986 helps illustrate the trends. These include:

- **Imaging reconnaissance**—During 1986 the Soviets launched 26 military imaging reconnaissance satellites, about the same number as in 1985. The U.S. attempted and failed in a reconnaissance mission launch attempt in March, 1986. "In its 25th year of operations, the Soviet photographic reconnaissance satellite program demonstrated yet again its quick response and flexibility, characteristics potentially crucial in a major conflict," Soviet space analyst Nicholas L. Johnson, advisory scientist with Teledyne Brown Engineering, Colorado Springs, said.

"Soviet photo reconnaissance posed another milestone in 1986 with the apparent attainment of operational status for its new advanced spacecraft [and] a marked increase in the expected number of satellites in orbit simultaneously," Johnson said in his report on Soviet space activities for 1986. The Soviets also launched five Salyut Earth resources satellites, a decrease from seven in 1985.

- **Communications satellites**—The Soviets launched 27 low-altitude communications satellites in 1986, up from 10 in 1985. Three of the 1986 missions involved eight satellites launched on one booster compared to only one such flight in 1985. The Soviets launched seven Molniya spacecraft into highly elliptical orbits compared with eight in 1985. They also launched six satellites into geosynchronous orbit in both 1985 and 1986. Their first geosynchronous mission attempt in 1987 ended in failure when the fourth stage of a Proton booster failed to ignite.

■ **Navigation**—Seven low-altitude navigation satellites were launched in 1986 compared with five in 1985. The Soviets placed three Glonass advanced navigation spacecraft in orbit on one booster in 1986. Two Glonass missions were flown in 1985.

- **Meteorological**—One new Meteor-2 satellite was launched in 1986, consistent with past Soviet practice of launching one or two such spacecraft annually. In addition, the Cosmos 1766 spacecraft was launched carrying a side-looking radar for oceanographic and ice observations.
- **Missile warning**—Seven missile-warning satellites were launched in 1986, the same number as in 1985.

■ **Ocean surveillance**—Two nuclear-powered radar ocean surveillance satellites and three electronic intelligence ocean surveillance spacecraft were launched by the USSR in 1986. The number was similar to that in 1985 but the activities were more diverse. The client payloads "demonstrated three new flight profiles and a new surveillance technique," Johnson said. □

Advanced Technology Moves Japan Toward Launcher Market

Tokyo—Japan is developing advanced space technology on a broad front in preparation for an incisive move into the commercial launcher market during the next decade.

License restrictions on technology purchased from the U.S. have delayed introduction of Japanese launch vehicles and spacecraft into the commercial market. But Japan has systematically positioned itself to become commercially competitive in space.

Until recently, Japan's low profile has discouraged competitors in the West from comparing Japanese development of space technology to earlier technological preparations in the automotive and consumer electronics fields (AWST July 14, 1986, p. 13). Those preparations led to Japanese exports capturing large shares of the world market.

Early in the next decade, Japan's strength in the space market will become apparent if the National Space Development Agency's H-2 launch vehicle proves reliable. Launch of the first H-2 prototype is scheduled for early in 1992 and the second for that summer.

Sales Groundwork

Mitsubishi Heavy Industries is developing the 328,000-lb., 151-ft.-long booster for the Japanese space agency, while laying the groundwork for capturing a substantial share of launch vehicle sales worldwide.

Mitsubishi is working on formation of an organization patterned after Ariane, a space of France that would market commercial launches on the H-2 at a price of about \$110 million each.

Japan's N-2 and H-1 vehicles are not available for launching overseas commercial payloads because much of the technology is purchased from U.S. companies such as McDonnell Douglas Astronautics Corp. However, McDonnell Douglas has

proposed to commercialize the H-1 immediately to assist the U.S. out of its booster crisis.

Japan so far has resisted commercialization of the H-1 because launches from Tanegashima island are restricted to January through February and August through September (AWST July 14, 1986, p. 18). The restrictions derive from lobbying by Japanese fishermen who are concerned about falling solid rocket boosters ruining the fishing around the island.

However, the Japanese Science and Technology Agency has decided to approve the deal if McDonnell Douglas directs an official request through the U.S. government.

Successful launch of an H-1 booster on Aug. 13 of last year bodes well for Japan's indigenous hydrogen/oxygen liquid propulsion technology that powers both the first and second stages of the H-2 (AWST Aug. 25, 1986, p. 25). Japan's National Space Development Agency (NASDA) plans to improve the H-1 second stage's LE-5 liquid-fuel engine. Using hydrogen gas to drive the turbo-pump is expected to deliver 26,500 lb. of thrust.

The second H-1 test launch of an engineering test satellite (ETS-5) is scheduled for the summer of this year (AWST July 28, 1986, p. 43). Launch of the first operational H-1 is scheduled for February of next year with a Mitsubishi Electric CS-3A communications satellite.

Japan has allocated \$423 million in fiscal 1987 for H-2 development, which officials of the government and the contractor agree is on schedule.

No commercial restrictions apply to the H-2 because the booster will use all Japanese technology. Also, the launch-season restriction may be lifted because the H-2's two solid rocket boosters will fall 300-360 mi. out to sea, well beyond the 120-mi. limit established by the fishing lobby (AWST July 14, 1986, p. 51).

Canada has proposed that Japan and Canada jointly use a future Canadian communications satellite in return for launch of the satellite on an H-2 vehicle.

Early evidence of Japan's commercial intentions also sketch the outline of an emerging market strategy comprising:

- **Lower costs**—Mitsubishi is designing the H-2 so its diameter is the same as the Japanese Experiments Module (JEM) for the U.S./international space station. The same tooling can be used to manufacture both systems if NASDA selects Mitsubishi as its module contractor (AWST July 14, 1986, p. 56).
- **Higher reliability**—Mitsubishi, which is in cooperation with Ishikawajima-Har-

Flak Selected For NASA Post

Washington—NASA has named Leonard A. Flak as its new associate administrator for space science and applications, effective Aug. 6. Flak succeeds Burton I. Eder, who will leave NASA in early spring. In addition to serving as a professor of physics, Flak was vice president for research and financial affairs at the University of New Hampshire. He formerly worked as an astrophysicist at NASA's Goddard Space Flight Center.

Chinese Make Inroads On Commercial Launch Market

Washington—People's Republic of China is building substantial momentum in the commercial market for launch services by capitalizing on the low cost of its serviceable but rudimentary space technology. China has taken advantage of suspended launch-to-acquire foreign currency and experience dealing with the West. The ultimate aim is to bring high technology into the country through cooperative ventures and enable China to compete in a broad range of commercial space markets during the next decade (AWAST May 26, 1986, p. 22).

Pan Am Pacific Satellite Corp.'s agreement to launch the Westar 6 spacecraft on a Chinese Long March 3 vehicle in May, 1987, culminated the latest series of successful marketing efforts by China's Great Wall Industry Corp. Pan Am plans to use the spacecraft, now known as PacificStar 1, to provide communications for island nations of the Pacific rim (AWAST Sept. 29, 1986, p. 21).

The marketing has come a long way since a delegation from Great Wall began selling commercial launch services by touring satellite facilities in the U.S. early last year (AWAST May 3, 1986, p. 17).

China's first sale of launch vehicle services was last June to Terasat, Inc., a Houston-based real estate consortium seeking to launch two satellites.

To make the sale, the Chinese guaranteed a rediff without charge in case of launch vehicle failure and offered a 10-15% discount off established prices for the shuttle and Ariane. Chinese launch costs are expected to remain low compared with those in the U.S. and Europe because of lower labor costs in China.

Competitive Edge

The People's Insurance Co. of China provides the Long March vehicle a competitive edge by offering launch insurance at a discount from the exorbitant rates charged by underwriters in the U.S. and Europe. People's Insurance is offering up to \$40 million of coverage for each mission.

On Jan. 28, Terasat and Great Wall signed a contract to launch Western Union's Westar 6-S in February, 1987. Terasat will pay for the Chinese Long March to place the spacecraft in orbit in return for partial ownership of the transponder payload (AWAST Feb. 2, 1987, p. 27).

Within China, preparation for launching foreign payloads is accelerating. Sun Jia Dong, China's deputy minister for space, plans to increase Chinese indus-

trial capacity to manufacture 12 Long March boosters annually. The Long March 2/3 series, which has launched 16 of China's 18 satellites, is custom manufactured as satellites near flight readiness. Chinese officials claim that of 18 satellites launched, eight were intended for recovery and all of these were recovered successfully. The Long March vehicle launched two satellites during 1986.

Commercial payloads from countries other than China will command a higher priority than China's own launch requirements.

Expanded launch facilities at Xichang are capable of handling at least six or seven missions a year. Chinese officials expect that only one or two a year for the next five years will involve Chinese communications, meteorological or Earth resources payloads (AWAST May 26, 1986, p. 21).

In addition to Westar 6-S and PacificStar 1, China has provisional launch contracts for three more U.S. spacecraft, four Brazilian satellites and several Swedish Malaysian spacecraft.

In February, 1986, Swedish Space Corp. signed a launch reservation agreement on use of Long March 2 vehicles to orbit the small electronic mail satellites. A Chinese remote-sensing satellite will be the primary payload on the first mission.

A selling point was China's ability to provide future piggyback launch opportunities on the Long March 2, which the Chinese regularly use to launch Earth observation spacecraft.



Large space platform concept by Mitsubishi Electric Corp. of Japan would accommodate a variety of communications and scientific missions on a single structure. Large antennas up to 100 ft. in diameter would require complex on-orbit deployment for communications among mobile users in aircraft, on board ships and in various types of land vehicles. The National Space Development Agency (NASDA) plans to test antennas of this size as part of Japanese participation in the U.S. space station program. At the current pace of the Japanese space program, a platform like the one depicted here is considered feasible in the late 1990s.

Chinese Satellite Offer

Cape Canaveral—The People's Republic of China is offering to lease space on its recoverable military reconnaissance/Earth resources satellites to international users. The Chinese also said they will discuss the lease of the entire payload capability of their recoverable satellite system or part of each payload.

China has launched and recovered at least eight large satellites that were involved in developing a military reconnaissance capability and returning civil remote-sensing film.

"In the U.S., General Electric and other companies have been trying to interest prospective users in a new recoverable system for materials processing or other research. The Chinese, if successful, could cut into this potential U.S. market, although U.S. efforts in this field have generated little interest."

Free Flier Launch

Japan's space-station effort is to include a \$200 million free flier launched on the third H-2 vehicle in February, 1993. The platform would remain in a 310-mi orbit for about six months and be recovered by the shuttle. Six leased modules would accommodate experiments in electronics, biotechnology and materials.

A follow-on to Japan's ERS-1 remote sensing satellite may join the multinational polar orbiting platform program, which is gaining momentum with support from the U.S. National Oceanic and Atmospheric Administration. Definition of Japanese payload concepts including a next-generation radar is expected to begin this year.

Mitsubishi Electric Co. has developed synthetic aperture radar for space-based remote sensing and will supply slot array

Earth observation—The MOS-1 marine observation spacecraft will begin operation next spring, and data will be delivered to 76 domestic and foreign government agencies, universities and research institutes. The Nippon Electric GMS-4 meteorological satellite will fly on an H-1 in the summer of 1989 to replace GMS-3 currently in service. An H-1 will launch the Mitsubishi Electric ERS-1 early in 1991. NASA's Jet Propulsion Laboratory plans to construct an ERS-1 receiving station in Fairbanks, Alaska.

Testing satellites—Mitsubishi Electric is developing ETS-5 under contract to NASDA. The spacecraft will evaluate performance of the H-1 vehicle, study three-axis control technology and conduct experiments with mobile communications between ships and aircraft. Mitsubishi Electric, Nippon Electric and Toshiba are jointly developing the \$260-million next-generation ETS-6, which is scheduled for an H-2 launch in 1992. The 4,000-lb spacecraft is considered a prototype for a future Japanese heavy satellite that would be offered for export.

Completed flights of Venus and Halley's Comet surveys have stimulated NASAS planning for future interplanetary missions using the Japanese space institute's verified launch and control technology. □

Free Flier Launch

Japan's space-station effort is to include a \$200 million free flier launched on the third H-2 vehicle in February, 1993. The platform would remain in a 310-mi orbit for about six months and be recovered by the shuttle. Six leased modules would accommodate experiments in electronics, biotechnology and materials.

A follow-on to Japan's ERS-1 remote sensing satellite may join the multinational polar orbiting platform program, which is gaining momentum with support from the U.S. National Oceanic and Atmospheric Administration. Definition of Japanese payload concepts including a next-generation radar is expected to begin this year.

Mitsubishi Electric Co. has developed synthetic aperture radar for space-based remote sensing and will supply slot array

Upper Stage Procurement

A Long March 4 booster capable of placing 4,500 lb in geosynchronous transfer orbit is in the concept definition phase, and Chinese officials have approached Martin Marietta on procurement of an upper stage for that vehicle. The Long March 3 has transfer orbit capacity of 3,100 lb.

Dong said China will develop a new expendable launch vehicle with transfer orbit capability for a 5,500-lb payload. Chinese plans also include development of a Saturn-1 class booster, and U.S. space officials who visited the Xichang launch site have determined that the facility can be upgraded to handle a booster of that size.

Satellite development in China currently emphasizes communications, military reconnaissance and Earth resources spacecraft. A remote-sensing satellite capable of transmitting images to Earth electronically is scheduled for launch between 1988 and 1990. This will supplement the film return spacecraft currently in use. China is negotiating with France on joint development of a new Earth resources satellite.

Development of meteorological spacecraft in China is expected to receive increased emphasis over the next five years. The Chinese are pursuing plans for cooperative science and technology experiments with the U.S. using the space shuttle (AWAST Mar. 10, 1986, p. 141).

Also, China wants to join the U.S./international space station program to gain advanced technology needed to carry its space program into the 21st century. Long-range planning includes launch of a Chinese-built space station and space shuttle by the year 2000. □

Free Flier Launch

Japan's space-station effort is to include a \$200 million free flier launched on the third H-2 vehicle in February, 1993. The platform would remain in a 310-mi orbit for about six months and be recovered by the shuttle. Six leased modules would accommodate experiments in electronics, biotechnology and materials.

A follow-on to Japan's ERS-1 remote sensing satellite may join the multinational polar orbiting platform program, which is gaining momentum with support from the U.S. National Oceanic and Atmospheric Administration. Definition of Japanese payload concepts including a next-generation radar is expected to begin this year.

Mitsubishi Electric Co. has developed synthetic aperture radar for space-based remote sensing and will supply slot array

Reagan to Consider Additional Funding for Station Program

By Craig Covault

Washington—Senior White House and space officials were preparing late last week to present President Reagan with a space station program recovery plan that could secure a new \$12.4-billion funding commitment for the project and reassert NASA intentions to keep the U.S./international project on course.

The new funding proposal would provide for a \$4.6-billion increase over the original \$8-billion target to keep the project essentially on schedule and without excessive reductions in initial capability. Additional features of the plan are designed to introduce funding and management stability in the program so NASA, its European, Japanese and Canadian partners, can move forward with a program unencumbered by excessive policy and funding changes.

If approved by President Reagan, the new station plan should allow release of the station hardware requests for proposals to industry without significant addi-

tional delay. Contractors told AVIATION WEEK & SPACE TECHNOLOGY that their ability to fund additional station work is nearly exhausted and any further delay in release of the RFPs could halt the effort and force a costly restart later.

The \$12.4-billion level being presented to the President would provide only a minimum station capability, however, and experienced NASA managers said they had hoped the level would be nearer \$16 billion. They also said the \$8-billion target for the last two years was "phony."

Public Declaration

In addition to urging Reagan to approve the new station plan, NASA officials also were expected to urge the President to make a new public declaration of support for the project as a message to both the U.S. Congress and international partners on the importance of the issue to the White House.

While the new station plan was being prepared for presentation to Reagan, NASA's Advisory Council was recommending that the space agency reexamine the ability of the shuttle to support the permanently manned facility.

An Advisory Council task force on the need for a shuttle/ expendable booster mixed fleet said shuttle support to the space station needs to be "revisited" and that NASA must build planning around the "inevitable unexpected standstills" that will occur in future shuttle operations.

Advisory Council Chairman Daniel Fink said the message his group wants to convey is a need to examine much more expendable booster support for station operations.

The task force was equally concerned about shuttle flight implications for future payloads.

"The task force is immensely sobered by the enormous budgetary costs, opportunity costs and program disruption of the current unplanned [shuttle] standstills," it said. The costs of the delays are in the billions of dollars. "This cost and disruption overshadows the heretofore custom of evaluating launch services on a 'cost to orbit if everything works' basis," the task force said.

"The task force well understands there are fixed annual costs associated with the shuttle operation. This has led many to conclude that economics dictates that the shuttle should be launched as often as possible in order to minimize costs per launch," the group said.

"This task force does not share that judgment. Rather, we place importance on

IUE Satellite Observes Supernova In Ultraviolet

Goddard Space Flight Center, Md.—Detailed observation of a supernova, the violent explosion of a star in deep space, was under way last week by the NASA International Ultraviolet Explorer spacecraft, which detected material being ejected from the explosion at velocities of 8,000 mi. per sec. The IUE telescope in geosynchronous orbit also discovered that the supernova resulted from the explosion of a star different from the one earlier believed responsible, a finding important to understanding the rare event that was detected Feb. 24 in the Large Magellanic Cloud 163,000 light years from Earth.

The Goddard-controlled telescope has been providing the only detailed space-based observation of the stellar explosion and the only observation of the supernova in ultraviolet.

The IUE telescope was launched more than nine years ago and is a joint project of NASA, the European Space Agency and the United Kingdom Science and Engineering Center. Scientists using IUE over nearly a decade have written more than 1,500 reports outlining new deep space discoveries.

When it first occurred, astronomers believed the star involved was Sanduleak, a blue super giant. Super giants are hot stars about 10 million miles in radius. By Mar. 4, however, IUE spectral data began to show that the blue super giant was still in place, and the explosion involved a different unidentified star at about the same position.

"It has been declining steadily and rapidly. Over the first 24-hr. period at shorter wavelengths, it declined by a factor of five or six. At longer ultraviolet wavelengths, the decline was limited to a factor of two," Dr. Yoji Kondo, IUE project scientist, said.

"Nobody had any idea how this sort

of enormous costs that are imposed on a helpless user community by delays in planned launch dates," the group said. "The task force also calculated that high launch rates with systems designed for high reliability do not equate to more 'incident-free' operations."

They found that with a 95% launch reliability factor, a vehicle flying 31 missions can expect only 28% of those missions to be "incident-free."

A vehicle with a 97.5% reliability factor flying 31 missions could expect only 53% of its missions to be incident-free. And a vehicle designed with 99.5% reliability flying 83 flights could be expected



Supernova image taken by the International Ultraviolet Explorer (right) shows how the exploding star appears in blue light imaged by the spacecraft's line error sensor. The image was digitized and color coded by computer, with red indicating the brightest area and blue and white less intense emissions as debris was thrown from the supernova at velocities of 8,000 mi. per sec. Supernova 1987A is identified above (arrow). The star that created the supernova may have been a companion to star Sanduleak minus 69 202, located near the star 30 Doradus in the Large Magellanic Cloud, which is about 163,000 light years from Earth.

of thing would go; we did not know how rapidly it would cool. We are finding in the ultraviolet it is getting fainter rapidly, indicating it is getting cool and expanding fast," he said. "We also are learning a great deal about the physical condition of matter between here and the Magellanic cloud."

The council said as many Defense Dept. payloads as possible should be diverted away from shuttle and the nation should rely on expendable boosters "unless shuttle-unique capabilities are required by the mission."

A heavy-lift expendable booster is required, according to the task force, although members differed on how it should be designed. Officials such as Air Force Secretary Edward C. Aldridge, Jr., have called for a "clean sheet" design not tied to shuttle hardware. The task force urged that the nation "examine the attractiveness of a shuttle-derived ELV."

The task force said NASA must recognize the need for more cooperation with the Defense Dept. in launch operations over the next few years. It also recommended that NASA Administrator James C. Fletcher and Defense Secretary Casper W. Weinberger sign a formal memorandum of understanding covering "common-use launch systems."

It said NASA must "accept the decision to remove NASA from responsibility for launches of commercial spacecraft" and the agency should "encourage development of commercial launch services with access to NASA facilities and technology at cost." □

Defense Official Challenges Continuing SICBM Development

By John D. Morrocco

Washington—A senior Defense Dept. official publicly questioned whether it was worth continuing development of the small intercontinental ballistic missile last week, despite the Administration's policy to develop both the SICBM and a rail garrison basing mode for additional MX missiles.

The statement by Fred C. Ikle, under secretary of Defense for policy, is certain to fuel the growing concern within Congress whether it is fiscally and strategically wise to proceed with both systems.

Testifying before the Senate Armed Services strategic and theater nuclear forces subcommittee, Ikle compared the \$50 billion he said it would cost to build 500 single-warhead SICBMs with the \$15 billion it would cost to deploy 50 MXs with 10 warheads apiece in a rail garrison basing mode.

In earlier testimony before the subcommittee, Lawrence W. Woodruff, under secretary of Defense for strategic and theater nuclear forces, put the cost of developing the SICBM at \$44.48 billion.

Woodruff also admitted, in separate testimony before the House Armed Services research and development subcommittee, that the Defense Dept. has not completed a thorough cost analysis of the SICBM, popularly known as Midgetman.

Sen. Albert Gore (D-Tenn.) charged that Ikle's testimony was a deliberate attempt to scuttle the SICBM. "You are coming before this committee and you are saying, read my lips, cut the money out from Midgetman," Gore said.

Ikle responded that he was only providing lawmakers with the "facts" and that any decision on the fate of either program was up to Congress. But when pressed by members of the Senate subcommittee, Ikle said: "I think it is not necessary to go ahead with the small ICBM. The cost is not justified."

If Congress had not directed the Defense Dept. to build the SICBM, Ikle said, development of the single-warhead missile would not have gotten as far as it has.

Ikle's testimony fueled speculation among some critics that the Administration was deliberately hiking the cost estimates of the SICBM to influence

Congress to drop the program as too costly.

House Armed Services research and development subcommittee staff member Anthony R. Battista said the Administration appeared to be preoccupied with the idea: "Let's make the SICBM so expensive that Congress will kill it."

Ikle's statements came during a round of Defense Dept. briefings on Capitol Hill outlining the cost and strategic necessities for developing both land-based ICBM systems. The Defense Dept. has asked for \$2.26 billion in Fiscal 1988 for the SICBM, which recently entered full-scale development, and \$590 million in Fiscal 1988 and \$1.2 billion in Fiscal 1989 to start rail-based MX system development.

In addition, the Defense Dept.'s total request for MX includes \$2.7 billion for continued deployment of the 50 MX missiles in Minuteman silos approved by Congress and procurement of the next 42 missiles—25 for the current flight test program and 17 for rail garrison deployment.

Woodruff, voicing the Defense Dept.'s official policy, said that developing both systems would provide a balanced nuclear deterrent force and move closer to a fully mobile and therefore more survivable land-based force in the event of a Soviet preemptive strike.

Budget Squeeze

Rep. William L. Dickinson (R-Ala.), the ranking minority member of the House Armed Services committee, warned Woodruff, however, that under the current budget squeeze Congress cannot afford the MX and the SICBM. "The money is just not there," he said. Dickinson said the Pentagon should reexamine its plan or else the entire Defense budget might "grind to a halt."

Woodruff received the same warning from Sen. J. James Exon (D-Neb.), chairman of the Senate Armed Services strategic and theater nuclear forces subcommittee. "It's not a question of whether we would like to have both, but whether we can afford to have both," he said.

Exon asked that the Defense Dept. examine the cost and effectiveness of going ahead with the rail garrison MX and building more Trident 2, D-5 submarine-launched ICBMs instead of proceeding with development of the SICBM.

R. James Woolsey, former secretary of the Navy, warned Exon, however, that the U.S. currently relies heavily on its seabased Trident submarine force as a deterrent against a sudden Soviet strike. "We are betting a great deal on the survivability

Thiokol Delays Firing of Shuttle Booster

Los Angeles—Morton Thiokol is delaying the U-2al is not planned for flight and is being used for advance testing of the similar J-2al concept, which is the baseline for the redesigned SRB (A-2al Feb. 9, p. 119). One side of the J-2al is vulcanized to the rest of the insulation in an autoclave, and the other side joins mating SRB segments with the adhesive film.

Concern with ETM-1 is that similar bond voids may have occurred during the manual installation of the motor's two U-2al seals, and that this may lead to a case burn-through on the 120-sec. test. ETM-1 already has been assembled and fitted with instrumentation.

The option to handle the potential bond voids with the least delay is to eliminate the U-2al seals, but this also would eliminate testing of the adhesive film, though there are several other test goals. This option is expected to result in the mid-May firing. Other options are either to rework the current ETM-1 segments or start with fresh segments and refit the U-2al using hard tooling to prevent the voids. Choice of option is to be made Mar. 20.

The first full-diameter hot firing test of the redesigned metal case-to-case joint, called JES-3A, is set for late June.

Task Force Urges NASA to Adopt Manned Mars Goal

Washington—The U.S. should establish the goal of a manned mission to Mars to regain leadership in space exploration with a program that will have long-term scientific and technological benefits to the country, according to the Space Goals task force of the NASA Advisory Council. The task force is headed by former Apollo 11 astronaut Michael Collins.

The task force stressed that development and operation of the U.S./international space station is an essential element in laying the groundwork for the technology that will be required to move manned exploration farther into the solar system to Mars and beyond. It also stressed the need to return the space shuttle to flight status as soon as possible and develop expendable launch vehicles to get the entire U.S. space program moving again.

The task force findings focused heavily on the recommendations of the earlier National Commission on Space, which also highlighted Mars exploration (AWST Mar. 24, 1986, p. 11).

The task force believes a Mars objective would enhance NASA's standing with the public, stimulate and clarify key programs and enhance national technical productivity and efficiency.

The objective should be pursued, however, only in connection with a solid foundation of precursor missions and technological development, including a balanced science program that also focuses heavily on Earth-oriented space programs, the task force found.

The task force calls for:

- An aggressive unmanned exploration of Mars to support longer-term manned Mars strategies.

- Increased research to build the technological base that would be needed to support development of a manned Mars initiative.

- Establishment of a realistic schedule for the project, including an assessment about whether the return of U.S. astronauts to the Moon should be a stepping stone to manned Mars operations.

- Establishment of a consistent space science effort that progresses through increasingly important science and technological milestones.

In addition to the scientific and technological needs and benefits involved in a manned Mars goal, the task force stressed that the lessons of history show that the opening of new frontiers and tackling of new technical challenges routinely stimulate extensive commercial activity and leadership requires expansion of human life beyond Earth, the group said. □

Titan 34D Tests Show Aging Not a Factor In Insulation Bonds

Los Angeles—Investigators studying the cause of the Titan 34D booster failure last April said aging tests conducted on booster motor sections show that the critical bond between the inside insulation material and the steel wall of the motor case remains strong in older segments.

Failure of the Titan 34D Apr. 18, 1986, seconds after launch from Vandenberg AFB, Calif., was caused by a weak insulation bond, but Air Force officials said they are not sure what caused the bond weakness. One factor that has been under study was the age of the motor segments for the April launch.

The aging tests—expected to be completed this month at Hill AFB, Utah, as part of the Titan recovery program—show that the age of segments manufactured up to about five years ago does not affect the strength of the insulation/case bond. The tests involve cutting motor segments in 2-ft. sections, and then dissecting those sections into one piece for testing.

In addition to aging tests, a pathfinder motor segment is being run through production machining and insulation processes to evaluate new procedures and controls that have been established for booster manufacture. The Air Force plans to build coprocessed samples when new booster motors are manufactured. The samples will use the same steel, insulation material and propellant and be used as possible test articles in the future.

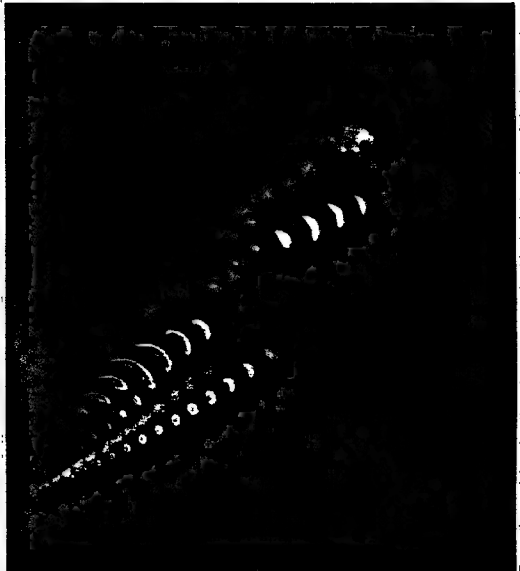
Another part of the Titan recovery program involves firing Titan motors and motor segments at Edwards AFB, Calif., to evaluate motor performance with minor quality discrepancies that have been identified by new nondestructive techniques.

The Air Force plans to start stacking a full 5½-segment Titan 34D solid rocket motor this month at Edwards in preparation for a static test firing on a former Saturn F-1 engine test stand at USAF's Rocket Propulsion Laboratory. The nozzle-down test stand has been modified for the 2-min. firing of the Titan motor.

The single full Titan motor test probably will be conducted in early April and be followed in May and June by a series of short-duration firings of two-segment motors. The short stack test series will involve use of inert as well as live propellant and have a firing duration of 8-12 sec.

About a half dozen tests are intended primarily to evaluate reaction of motor segment joints to sudden pressure increase at ignition. The tests also will be used to develop launch temperature criteria by using air-conditioning equipment at the test stand to chill motor joints.

NASA Uses Supercomputer for Aerodynamic Simulation



Formation and deterioration of vortices on a simplified cylindrical aircraft fuselage are shown in this pressure cross section developed using a Cray 2 computer at the NASA-Ames Research Center. Slightly asymmetrical flow over the fuselage also is shown in the image which was developed at Ames numerical aerodynamic simulation facility.

Los Angeles—National Aeronautics and Space Administration's supercomputer system at Ames Research Center, the numerical aerodynamic simulation (NAS) system, has become fully operational as a national facility primarily focused on aerodynamics research programs such as the National Aerospace Plane (NASP).

The NAS system—located in a two-story, 90,000-sq-ft. facility at Ames—has the most powerful version of Cray Research's Cray 2 supercomputer, capable of maintaining a sustained level of 250 million computations per sec. and top speeds of 1.72 billion computations per sec. The Cray 2 has a 256-million-word internal memory.

Design Studies

The NAS facility, with its more than 30 workstations tied directly to the central processor, is involved in the study of engines and fuselage designs for the aerospace plane project, as well as the integration of the NASP propulsion system to the fuselage. The system is directly connected to major U.S. aerospace companies.

The facility is considered to be one of the world's most advanced computer systems and will have an evolving capability to remain at the forefront of computer technology as new and more powerful systems become available, according to NASA. Super-

tailed speed is scheduled to be increased to 1 billion computations per sec. at NAS next year with the acquisition of a second high-speed processor, and should grow to 10 billion computations per sec. within 10 years. NAS funding through Fiscal 1988 will be \$126 million.

The NAS program was conceived in 1975 when researchers realized the need for significantly increased computer power and memory to solve three-dimensional fluid flow models. The program was actually established in 1983. The system has been expanded steadily at Ames and reached an interim operational configuration last July, when a network of workstations around the country was established. Fully operational capability was reached this week with component installation and checkout in the new Ames NAS building.

NAS is expected to reduce the amount of time and cost involved in developing designs and wind tunnel testing with its capability of simulating aircraft in flight.

The aerospace plane program will be a major focus of the system because of the difficulty of testing NASP designs in wind tunnels above Mach 7, due to the scale involved and energy requirements. Speed and memory of the NAS system is expected to allow for simulation of more complex aircraft configurations and more accurate approximations of Navier-Stokes equations used to describe the flow of air around a solid body.

Major components of the NAS system currently include the Cray 2 supercomputer, two Andahil 5840 computers, four Digital Equipment Corp. VAX 11/780 computers, 27 Silicon Graphics Integrated Raster Imaging System (IRIS) 2500 turbo-graphics workstations and 11 IRIS 3030 graphics workstations.

The NAS system also uses 34 Control Data Corp. DDAs and 230 Andahil 6380 disk drives.

System Access

In addition to aeronautics applications, the computer system—which is available to researchers at universities and in government as well as industry—will be used for weather modeling, computational chemistry, astrophysics and biological research. More than 27 sites located around the country will have access to the system through satellites and high-speed ground links.

Other numerical aerodynamic simulation aerospace work includes design of a crew escape system for the space shuttle, redesign of the shuttle main engine for improved efficiency, study of aircraft motion at high angles of attack and advanced helicopter design. However, program officials said that much of the complex work on advanced helicopter technology will have to wait for the next-generation supercomputer.

Soviets Demonstrate Flight Readiness With Firing of Heavy-Lift Booster

Washington—The Soviet Union has conducted a flight readiness firing of its heavy-lift booster/shuttle launch vehicle on the pad at the Baikonur Cosmodrome, Tyuratam.

The live countdown and static firing, which lasted several seconds, is the most significant milestone achieved by the 6.6-million-lb.-thrust Soviet vehicle to date.

First unmanned flight of the Soviet heavy-lift vehicle is expected by midsummer, while first flight with the manned shuttle attached to the heavy-lift vehicle could occur by late 1987 or early 1988, U.S. intelligence sources said. That would be in advance of the U.S. shuttle's return to flight status. The Soviet shuttle orbiter was not attached to the Soviet heavy-lift booster during the flight readiness firing, and did not have to be enabled checkout of its propulsion system.

Unlike the U.S. shuttle, the Soviet orbiter has no launch propulsion of its own. Instead, it rides piggyback on the booster. The Soviet firing, therefore, is comparable to the same type of prelaunch propulsion tests conducted earlier with U.S. shuttle vehicles, although for the Soviet vehicle the test was equally useful for both the shuttle and unmanned heavy-lift configurations.

The Soviet firing involved the large core stage that functions like the U.S. shut-

tle's external tank, except that on the Soviet version the main engines are mounted within the base of the core instead of on the back of the orbiter.

It also involved the large Soviet liquid-fuel strap-on boosters attached around the core.

The Soviet vehicle has at least four liquid strap-on boosters serving the same purpose as the U.S. shuttle's solid rocket boosters. The Soviet strap-on rockets are arranged to allow placement of the Soviet orbiter on the side of the vehicle for manned launches or attachment of an unmanned cargo pod for unmanned heavy-lift flights.

The Soviet unmanned heavy-lift vehicle will be able to place 220,000-lb. payloads into orbit—a capability the U.S. will not be able to approach until the mid-1990s at the earliest. Once the U.S. Strategic Defense Initiative heavy-lift vehicle is available, however, it will have a payload capability, 70,000-120,000 lb., less than the Soviet heavy-lift vehicle.

In addition to the ground test activity, cosmonauts Yuri Romanenko and Alexander Laveikin have been conducting materials processing work on the Mir space station which could give the USSR a lead over the U.S. in this area.

The Soviets said the Mir processing involved production of new semiconductor materials. They also said the USSR is planning to launch small unmanned materials processing spacecraft that would process such

materials free of manned interference, then dock with the Mir so the cosmonauts could retrieve the material for safe return to Earth.

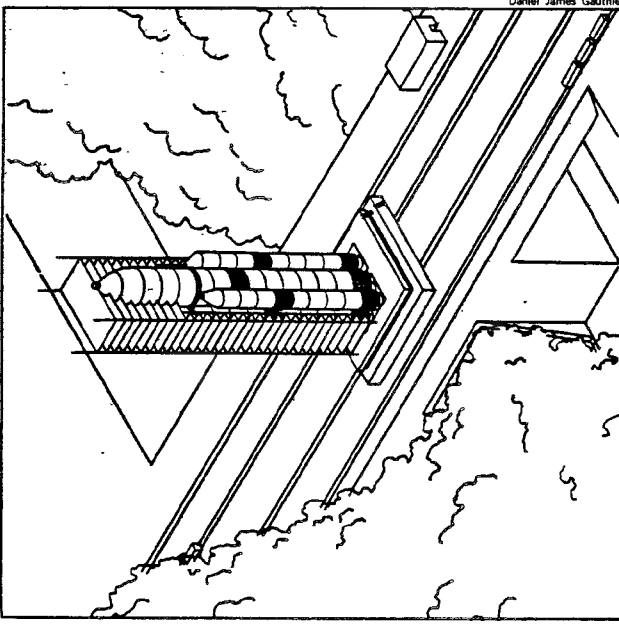
The Soviets already have flown at least two unmanned materials-processing spacecraft that returned their samples directly to Soviet ground forces.

The zero-g processing on Mir involves two units, one designated Pion-M and the other Korund (carborundum) furnace. The Soviets said the Pion unit is being used to "investigate the process of heat and mass transfer in a liquid media."

Crew radio communications about work on the Korund furnace were monitored by Geoffrey Perry of the Kettering Space Observer group in England. Perry monitored audio timing beeps associated with the processing. In addition to the space processing, the crew began unloading the new Progress-28 tanker/transport that docked with Mir's rear port Mar 5 (NASA Mar. 9, p. 269). On Mar. 9, Romanenko and Laveikin used the tanker's engines to boost the station's orbit slightly.

The Soviets said that Laveikin had experienced a "rather painful" adaptation to zero-g at the start of the mission.

The crew reported seeing an unexplained ocean phenomenon, "powerful concentric waves going out in the midst of a serene sea." The cosmonauts did not report where they saw the waves but said the circular features were many miles across.



Soviet Saturn-5 class heavy-lift booster, also used as the Soviet shuttle launch vehicle, ignites on its launch pad at Tyuratam in this illustration showing the recent flight-readiness firing of the vehicle to verify its systems for first flight. The 6.6-million-lb.-thrust vehicle can be flown in this configuration as an unmanned heavy-lift booster carrying 220,000 lb. to orbit, or manned with the Soviet shuttle orbiter attached to the open side of the rocket. Exhaust is ejected out of the multistage flame trench at the base of the launch pad.

Stanford/TRW Team Demonstrates Potential Lethality Increase Of Space-Based Free-Electron Lasers

Los Angeles—A team of Stanford University and TRW scientists demonstrated a potential increase in space-based laser lethality in late February by operating a free-electron laser at visible wavelengths.

The FEL was driven by a superconducting radio-frequency accelerator—a type of accelerator that may be scalable for space use—and the Stanford demonstration at 0.525-micron green light was the shortest wavelength output from this accelerator type. The short wavelength is important since for fixed-aperture optics the laser beam brightness, and hence lethality, varies inversely as the square of the wavelength.

Modified Accelerator

The green light was achieved by modifying the accelerator for higher electron energies and tuning the laser cavity for the shorter wavelength. Wavelength is inversely proportional to the square of the electron energy for a given laser cavity, so the 66 million electron volts previously used to generate 1.6-micron near-infrared light was boosted to 115 MeV for the recent tests.

Primary challenge in increasing the Stanford superconducting accelerator energy was keeping the electron pulses short to maintain the high peak currents required for lasing, according to George R. Neil, TRW scientist on the project. Pulse length tends to increase with higher energies, but

a pulse compressor was added that takes what is originally a 10 picosec. pulse and shortens it to 3 picosec. in the laser cavity. Peak cavity power is about 200 megawatts.

The optical cavity dimensions have to be more precise with the shorter wavelength light for lasing to occur, with about a 2-micron allowable error. A mechanical drive brings the cavity length to within 100 microns of its roughly 41.6-ft. proper length. A piezoelectric cell then moves the cavity mirror until lasing occurs.

Changes in optical cavity length during lasing are compensated for by altering accelerator frequency, as this is more responsive than the piezoelectric cell.

Highly reflective mirrors were needed for the short-wavelength lasing. About 99.94% of the incident light was reflected while 0.03% was transmitted and 0.03% was absorbed by the mirrors, leaving a 60-kw. beam coming out of each end mirror. Peak light intensity on the mirrors is about 3 gigawatts per sq. cm. in the 3-picosec. micropulse, giving an average power of 140 kw. per sq. cm. over a 5-millisec. macropulse made of micropulses spaced 84 nanosec. apart. The macropulses repeat every 0.1 sec.

Stanford scientists plan to push to even shorter ultraviolet wavelengths in December. Strategic Defense Initiative funding of the project has been through the Office of Naval Research in Pasadena, Calif. □

ing so-called exotic technologies such as lasers and particle beams based on what the treaty calls "other physical principles," i.e., technologies other than those incorporated in ABMs in 1972. Under the traditional interpretation of the treaty, it is permissible to test and develop fixed, land-based exotics, but not mobile/space-based ones. But deployment of all exotics is prohibited, whether fixed, land-based or mobile/space-based, subject to an agreement by the signatories to amend the treaty.

Test and Development Issue

Despite Weinberger's statements about early deployment, the White House has been careful to argue that the immediate issue before the President is not in fact early deployment, but rather the shape and extent of further testing and development—whether to transgress the traditional prohibitions against these activities. The debate is the more difficult because the boundary between research and testing, and between research and development, is indistinct.

Nunn, a lawyer and the Senate's main military expert, buttressed the congressional challenge to the Administration's legal thinking, which was set forth a year and a half ago by Abraham D. Sofaer, the State Dept.'s legal adviser, who had reviewed the ABM treaty negotiation record (AWAST Feb. 16, p. 16).

In the first installment of his three-part legal analysis of the treaty and its relationship to SDI, Nunn renewed his recent warning that treaties are the law of the land and that the Administration's unilateral interpretation of the 1972 agreement raises profound constitutional questions about the Senate's role in ratifying treaties (AWAST Feb. 16, p. 17). If reinterpretation is not legally correct, "then manipulating the law of the land is not acceptable," he said. Among Nunn's other findings, made in association with Senate Armed Services Committee counsel, were these:

- The ratification record contains a series of authoritative statements from both Nixon Administration officials and senators, making it clear that the treaty's prohibition of testing and development of mobile/space-based ABM systems or components applied to exotic systems.

- Opposition to the treaty in 1972 stemmed from the testing and development prohibition on mobile exotics—"a limitation commonly understood by both proponents and opponents of the treaty."

Nunn drew a distinction between the legal issue of interpretation and the policy question of continued U.S. compliance with the treaty in the face of alleged Soviet

enunciated in 1972, when the ABM treaty was ratified by the Senate, or the broad interpretation announced by the Reagan Administration in 1985, "with no advance notice or congressional consultations."

Nevertheless Nunn cautioned his Senate colleagues, the American public and U.S. allies that the nation may have to resort to strategic defenses if its military vulnerabilities to the Soviet Union are not resolved, either through arms control or deployment of more advanced weapons.

The kinetic technology now in research is designed to destroy strategic ballistic missiles by means of high-speed collisions. Early this year, Weinberger provisionally tagged kinetic devices as the candidate for first-phase deployment of a multilayered, space-oriented antimissile system, if the President decides in favor of near-term deployment.

At present, Administration officials are weighing what the White House has called a different pattern or configuration of SDI testing. Under this, kinetic devices presumably could be tested and developed legally within the Administration's broad but unilateral treaty interpretation (AWAST Jan. 19, p. 22).

No stepped-up development or deployment decisions have been made known publicly, although some congressional officials have asserted that SDI executives have already begun shifting funds away from long-term beam weapon technologies toward the kinetic kill category, in anticipation of a go-ahead for early deployment.

In the meantime, the Strategic Defense Initiative Organization is fleshing out a list of test and development options, due on the President's desk Apr. 30, that would fall beyond the narrow interpretation of the treaty.

Focus of Debate

The debate centers on the conformity of SDI research activities to the ABM treaty, which bans testing, development and deployment of antimissile systems or components, whether air-based, sea-based, space-based or mobile land-based.

Deployment of all ABM systems was prohibited except at two designated sites (later reduced to one) in each nation and at those sites, ABM systems were limited to fixed, land-based components comprising technologies available in 1972—ABM missiles, launchers and radars. Research on these components was not limited, but their testing and development were confined to agreed-upon test ranges.

As with fixed, land-based ABM components, research also was permitted for the mobile and space-based categories, includ-

Nunn Affirms 1972 ABM Pact, Finding Kinetic Tests Illegal

By Paul Mann

Washington—Kinetic kill vehicles—high-speed antimissile projectiles—probably cannot legally be tested or developed under either a narrow or broad interpretation of the 1972 U.S./Soviet Antibalistic Missile Treaty, Sen. Sam Nunn (D-Ga.), chairman of the Senate Armed Services Committee, said last week.

If correct, Nunn's conclusion would dash Defense Dept. hopes for early deployment of a partial antiballistic missile defense, because in recent months kinetic kill vehicles have become the department's preferred technology for near-term deployment, perhaps in the first half of the 1990s.

In addition to this potential programmatic effect, the senator's detailed legal analysis will strengthen the hand of those in the Democratic-controlled Congress who oppose the Administration's broad interpretation of the ABM treaty. They regard it as tantamount to abrogation and a trigger to an expensive and unlimited space arms race with the Soviet Union (AWAST Jan. 26, p. 22).

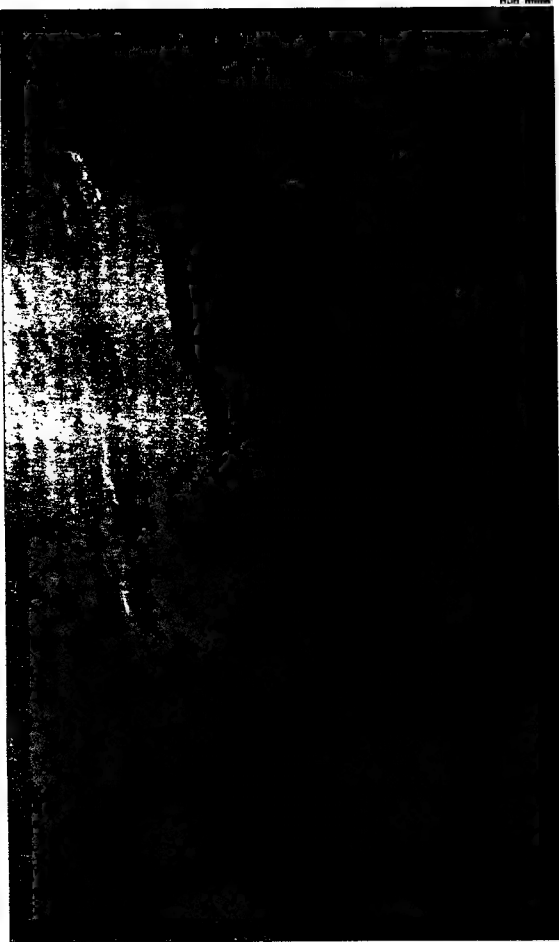
The broad interpretation holds that the treaty permits the testing and development of mobile and space-based exotic weapons technologies, "exotic" referring to technologies not current in 1972. The narrow and original interpretation holds that the treaty prohibits such testing and development.

Nunn said he had concluded that the Nixon Administration presented the Senate with the traditional interpretation of the treaty's limits on mobile/space-based exotics. "I have also concluded that the Senate clearly understood this to be the case at the time it gave its advice and consent to the ratification of the treaty. In my judgment, this conclusion is compelling beyond a reasonable doubt."

He said the Reagan Administration's broad interpretation invites the Senate "to apply the classic line of cross-examination to the Executive Branch: 'Should we believe what you were telling us then [in 1972] or should we believe what you are telling us now?'"

Advocates of the broader interpretation, in the name of trying to accelerate antimissile research or facilitate early deployment of an ABM system, may be laboring under a misimpression, Nunn said. He said there is a strong case that the specific Strategic Defense Initiative system of kinetic kill vehicles now favored by Defense Secretary Caspar W. Weinberger cannot legally be developed or tested under either the traditional narrow interpretation

NASA Begins Work on Mars Mission To Rejuvenate U. S. Space Program



By Craig Covault

Washington—Extensive exploration of the planet Mars is emerging as the key for rejuvenating the U. S. space program with an effort that would advance technologies, provide more direction to the space station and reassert U. S. space leadership into the 21st century.

NASA has begun defining an unmanned Mars rover/sample return mission that could launch in 1998 and return a sample to the U. S./international space station in 2001. Mission development would combine the manned flight expertise of the Johnson Space Center, Houston, with Jet Propulsion Laboratory's planetary flight experience.

The effort is designated the baseline Mars mission. The JPL/Johnson team will hold a contractor briefing Mar. 31, and award four rover/sample return vehicle definition contracts to industry by October.

The European Space Agency asked NASA last week how Europe can become involved in the effort, and engineers in NASA's Office of Aeronautics and Space Technology have been told to start turning their efforts toward Mars mission planning.

The rover vehicle would explore canyons and other terrain, picking up sam-

ples that would be delivered to the Earth return vehicle for launch from the Martian surface.

A Mars rover/sample return project office is being established at Johnson to help ready U. S. capability for the unmanned effort and position NASA to manage a future U. S. manned mission to Mars.

In addition to the baseline mission being defined by JPL and Johnson, NASA's Strategic Planning Council is reviewing an even more ambitious Mars effort that could be part of a new U. S. space Leadership Initiative being readied for presentation to President Reagan.

Top-Level Review

A top-level review of the plan is to be presented here Mar. 18 to key U. S. space advisers from outside NASA, including former Apollo 11 commander Neil A. Armstrong representing the National Commission on Space, which has outlined extensive Mars mission options (AWST Mar. 24, 1986, p. 11). Another outside task force headed by former Apollo 11 command module pilot Michael Collins also has endorsed accelerated Mars exploration and a manned Mars goal (AWST Mar. 9, p. 263).

The NASA Leadership Initiative, if approved, could expand and accelerate the baseline Mars effort to a much more am-

bitious rover/sample return mission that would be launched in 1996 on the new Saturn-5 class Strategic Defense Initiative heavy-lift booster. The U. S. Air Force/SDI booster also is being examined more intensively as the primary launch vehicle for U. S. space station elements instead of the space shuttle.

Under the Leadership Initiative, the accelerated Mars effort would use the JPL/Johnson infrastructure being formed for the baseline mission. One objective of the baseline work is to create a Mars management team so that NASA will be ready to react quickly to an accelerated Mars effort following presidential approval.

The more ambitious Mars mission would provide greater returns for science and stimulate a broader range of U. S. technologies, including robotics.

It would also return samples to Earth before the year 2000—a faster schedule than the baseline option. A chief goal would be to prevent the Soviet Union from taking the lead in Martian exploration. The more ambitious mission also would lead to a continuing U. S. presence on the Martian surface, including landing U. S. astronauts on the planet, NASA managers said.

Cooperation with the Soviets is an option, although NASA Administrator James C. Fletcher and other officials re-

A Mars rover is shown approaching a sample return booster (opposite page) illustrating the baseline Mars mission for which NASA is about to issue definition contracts. The Jet Propulsion Laboratory rover is about to put samples in the Soviet launcher, showing how a cooperative mission could be divided. U. S. officials, however, are concerned about involving the Soviets in a project designed to reassert U. S. space leadership. Comet rendezvous/asteroid flyby spacecraft (this page, left) will be sought as NASA's highest priority science start in the Fiscal 1989 budget to begin a series of major new planetary missions. The spacecraft will be a Mariner Mk. 2 class vehicle that will fly in formation with the comet Tempel-2 for three years, fire a penetrator into its surface and finally maneuver to fly by a large asteroid. JPL will manage new study contracts on a rover that will be part of the sample return. The rover (this page, right) is sampling a permafrost layer several feet below the Martian surface.

main cool to Soviet involvement because NASA's objective is to establish clear U. S. space leadership.

In addition to Mars exploration, NASA's Strategic Planning Council is focusing on more intensive observation of Earth from space. It also is examining the ability to shift manned flight priorities toward the Moon if necessary to counter any manned Soviet lunar base activity.

The council is composed of top space agency managers. Studies supporting the council are being coordinated by astronaut Sally K. Ride.

Officials told AVIATION WEEK & SPACE TECHNOLOGY the council has reached the consensus that any Leadership Initiative presented to Reagan must have a major focus on Mars, and that the Earth monitoring program also should be recommended highly.

The space station would be an integral part of the Mars efforts. The station would provide the necessary sample quar-

antine base and develop critical technology and life sciences capability to support the missions, both manned and unmanned.

The baseline Mars mission and Leadership Initiative also include one or more small reconnaissance "precursor missions" following the NASA/RCA Mars Observer spacecraft, set for launch in 1992.

In addition to the initial, smaller-scale Mars flights, the baseline and Leadership Initiative include a balanced planetary effort that would send new missions to the comet Tempel-2 and planet Saturn.

As part of this, a comet rendezvous/asteroid flyby mission will be NASA's highest new science priority for Fiscal 1989, and a vehicle could be launched on a Titan 4 in 1993. The spacecraft would fly in close formation with Tempel-2 for nearly three years and fire an instrumented probe into the comet's nucleus. In 1995 the spacecraft would separate from the comet and fly near the asteroid Hestia for

close-up photographs of the 80-mi.-dia. body.

The Saturn mission would be a top priority Fiscal 1991 new start. It would involve the launch in 1996 of a Saturn orbiter spacecraft carrying a probe that would be fired into the atmosphere of Saturn's moon, Titan.

Under the more extensive Leadership Initiative, however, the Saturn flight, like the Mars mission, could be launched on a Strategic Defense Initiative heavy-lift booster.

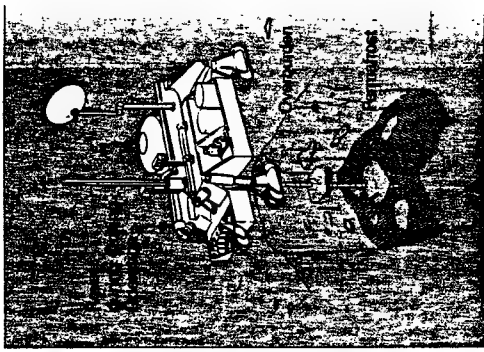
With the SDI booster, instead of a Titan 4, the mission could carry two additional probes. One would be a hard lander to characterize Titan's surface and the other a Saturn atmospheric probe.

Cost would be \$10 billion over 10 years for the advanced Mars mission, including four SDI heavy-lift booster launches, the Mars precursor flights and the comet and Saturn missions. The Strategic Planning Council found the costs attractive because they would peak at no more than about \$1.2 billion annually.

The baseline Mars mission activity is separate from this and will use money already approved. It would need formal new-start funding in Fiscal 1993, but NASA definition funding already is being spent.

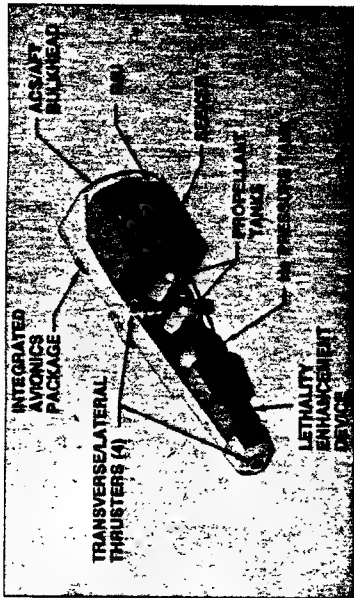
The Jet Propulsion Laboratory will lead the overall project and be responsible for the rover and the Mars orbiter portions of the mission.

The Johnson Space Center will control

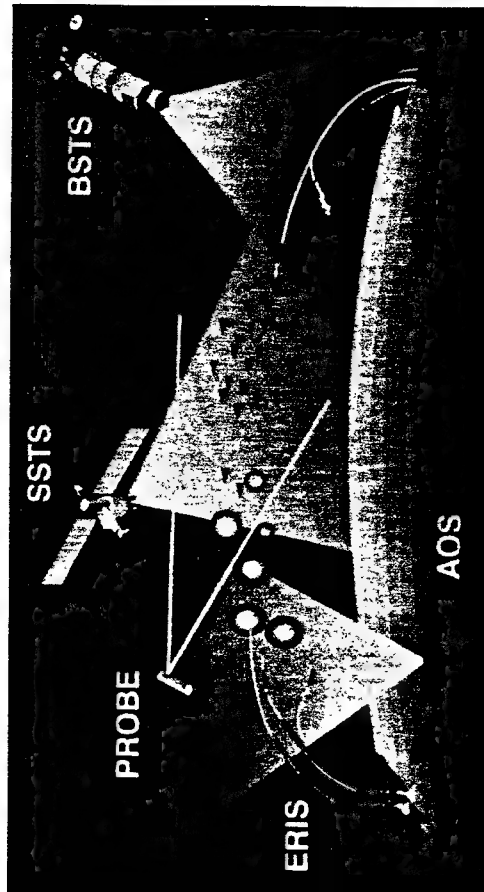
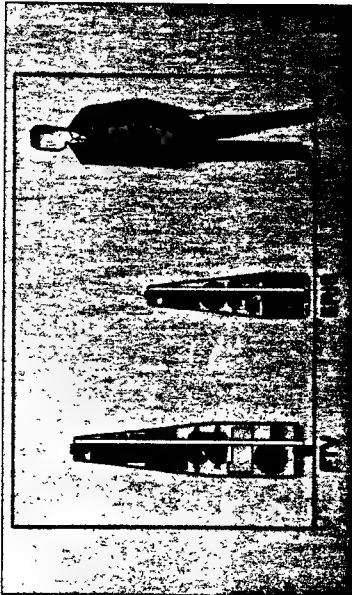


STRATEGIC DEFENSE INITIATIVE

Lockheed Developing ERS Interceptor Vehicle



Artist's concept of Army/Lockheed exo-atmospheric reentry-vehicle interceptor system (ERIS) (upper left) depicts a device that would deploy just before impact to expand the vehicle's lethal kill area. Lockheed Missiles and Space Co., Sunnyvale, Calif., is developing ERIS, a nonnuclear system designed to attack Soviet intercontinental ballistic missile reentry vehicles during the latter stages of their trajectory, under a \$468-million, five-year Strategic Defense Initiative Organization contract awarded in early 1986. The ERIS kill vehicle also contains an inertial measurement unit (IMU) and an attitude control system (ACS) to control the transverse and lateral thrusters. Helium is used to pressurize the fuel tanks and as a propellant for the thrusters. The ERIS baseline kill vehicle is compared to a 6-ft. man in the center artist's concept. The functional technology validation (FTV) interceptor vehicle is larger because it contains telemetry systems required for testing. Artist's concept of the midcourse portion of a layered ballistic missile defense (lower left) includes a boost surveillance and tracking system (BSTS); a space surveillance and tracking system (SSTS); a long-wave infrared surveillance device (PROBE); ERIS, and the Army/Boeing-Hughes airborne optical system (AOS). PROBE is a launch-on-warning system. Lockheed's contract provides for five test flights at Kwajalein Missile Range. Cost must be less than \$1 million per missile if ERIS is to become part of any layered ballistic missile defense system, according to SDIO officials (AWST Mar. 9, p. 38).



AVIATION WEEK & SPACE TECHNOLOGY/March 16, 1987 73

Companies Submit Commercial ELV License Requests

Washington—Commercial expendable launch vehicle companies have submitted several mission review and launch license requests to the Transportation Dept., which is charged with regulating U.S. commercial launches, and Transportation officials expect firm launch contracts to be signed soon.

Martin Marietta has asked the Office of Commercial Space Transportation to review two payloads for launch, and another company is expected to submit a similar application soon, Courtney Stadd, director of the office, told a Senate panel Mar. 5. In addition, American Rocket Co. has requested a license for a test launch later this year of its Industrial Launch Vehicle, a small payload space booster, he said.

The space transportation office requested \$4 million in Fiscal 1988 funding to perform regulatory research pertaining to the commercial ELV industry and additional funding to staff its office.

Despite the recent progress made by U.S. commercial ELV companies, some members of the Senate Commerce, Science and Transportation Committee remain skeptical of the prospects for U.S. companies to succeed in the international launch market.

"The policy-making process for the commercialization of ELVs has been a folly—one of the worst this committee has ever seen," Sen. Ernest Hollings (D-S.C.), chairman of the committee, told Stadd. "The fact that the commercial industry may emerge from the failures of 1986 is a miracle—one that nobody can take credit for."

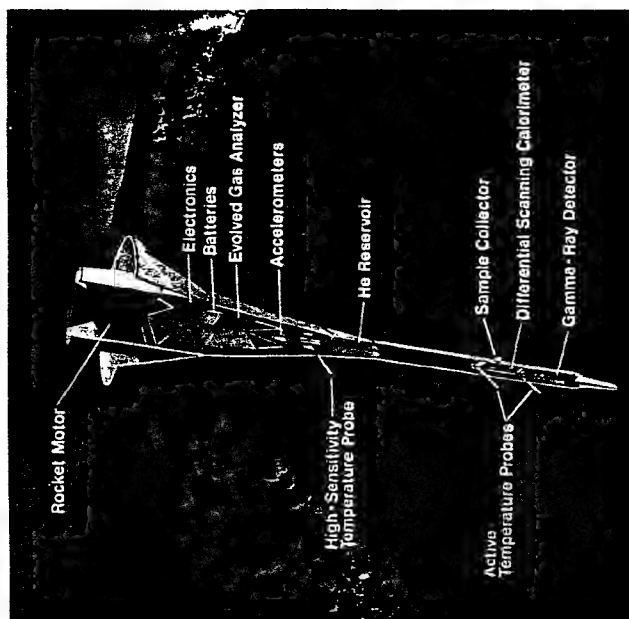
Sen. Lloyd Bentsen (D-Tex.) said that every three satellite launch sales lost by U.S. companies to foreign providers is financially equivalent to importing 10,000 cars into the U.S. He said he and other senators are concerned about the imbalance in trade the ELV industry is beginning to represent. □

Shultz to Ask Soviets to Sign Space Pact

Washington—Secretary of State George P. Shultz will ask Soviet Foreign Minister Eduard Shevardnadze whether the USSR is ready to sign a new U.S./Soviet civil space cooperation pact when Shultz visits Moscow in April.

During November, the U.S. and Soviet Union negotiated the agreement, which covers 16 different space activities (AWST Nov. 10, 1986, p. 27).

Many of the points in the agreement involve Mars exploration and would be important to near-term cooperation between the two countries on missions to that planet. The two sides have been waiting for a summit meeting between President Reagan and Soviet General Secretary Mikhail S. Gorbachev to formally sign the document. Shultz, however, now has been instructed by the White House to raise the possibility of signing the agreement with Shevardnadze instead of waiting for a summit meeting, which could take months or longer to arrange.



Ball Aerospace and the University of Arizona are defining a comet penetrator that will be fired into Tempel-2. The penetrator is shown here imbedded about 3 ft. in the comet's surface.

If the Leadership Initiative with the more advanced Mars mission is approved, then the plan would require four launches using the SDI heavy-lift booster. This would result in three Martian sample areas—two equatorial locations and one polar site.

The rover for the accelerated mission would have "vastly superior" sampling capabilities compared with that of the baseline mission, officials said. Robotics development spinoffs would significantly benefit U.S. industry, according to NASA managers. □

Johnson will issue two \$350,000 contracts to study Martian aerobraking and atmospheric entry and descent issues. JPL and Johnson will begin devoting significant manpower to the project. Science Application, Inc., Chicago, will act as support contractor. A request for proposals on the definition contracts will be released May 1, with contractor selection planned by October.

The baseline mission would use two Titan 4 launches, one for the rover and one for the sample return vehicle. In addition to a dedicated U.S. mission, contractors will be instructed to explore having the U.S. and Soviet Union split the rover/sample return vehicle developments as a potential cooperative project.

26 AVIATION WEEK & SPACE TECHNOLOGY/March 16, 1987

New Shuttle Launch Procedures May Result in Countdown Scrubs

By Craig Covault

Kennedy Space Center—New conservatism and discipline being incorporated into a complete revision of shuttle launch operations here will result in numerous launch scrubs to ensure safety once the program resumes flight operations, managers believe.

Flight operations will not resume until about July, 1988, many managers believe. A return to Gemini/Apollo type launch processing philosophy here will buttress safety but force adjustments in the scheduling of a wide variety of civil and military space operations for years to come.

Kennedy is defining a more highly structured process to review all flight safety issues during countdowns. That process is expected often to exceed launch window time constraints, managers said.

Kennedy has had 400 personnel on 54 teams examining 4 million pages of documentation and 2,700 launch site "hazard issues" in its reassessment of U.S. manned launch operations.

Kennedy managers also are monitoring work on two new shuttle main engine flight safety issues. One new finding "has all the earmarks of another O-ring experience," a senior Kennedy manager told AVIATION WEEK & SPACE TECHNOLOGY.

He was referring to the discovery of a potentially critical phenomenon in the propellant lines between the external tank and shuttle orbiter that previously was not widely appreciated by shuttle engineers.

The concern involves the 17-in.-dia. oxygen/hydrogen disconnect valves in the belly of the orbiter where propellant from the external tank enters the vehicle.

A reassessment of this valve system was under way to increase assurance that a valve would not accidentally close causing the vehicle to explode. During bench tests of the valves, however, they were found to be fluttering rapidly up and down in a vibratory motion instead of being held open firmly as liquid oxygen and hydrogen pass over them at rates approaching 18,000 and 49,000 gallons per minute, respectively, the manager said.

That fluttering could have serious implications for valve failure modes, although that is still being assessed.

"It is obvious we did not know as much about those valves as we thought—like the booster O-rings," the manager said.

The oxygen/hydrogen valve assemblies were pulled here in late February from the Discovery, which will make the first flight once missions resume.

Another flight safety assessment is under way on Discovery's Rocketdyne main

engines. Main engine managers have raised questions about the acceptability of welds in the heat exchanger coils on two of Discovery's engines.

The weld area in question is difficult if not impossible to inspect. If no way is found to inspect those welds, a decision will have to be made on whether it is advisable to fly the engines on Discovery.

Certifying a new set of Discovery engines would cost the launch schedule several months.

The effort to install new conservatism and discipline into maintenance and launch operations here has kept the Kennedy engineering workload at a pace equal to that prior to the accident. Overtime work has been running at 10-13% for many managers.

Before flights resume, the output of all reviews under way here is expected to require redistribution of 15 million pages of revised maintenance and launch-oriented documentation throughout the space program, Robert B. Sick, shuttle launch director, said.

"I think we all feel the February launch target will be impossible to make," Gene Thomas, Kennedy director of safety, reliability and quality assurance, told AVIATION WEEK.

"There is an overwhelming amount of work to do," George I. Sasseen, Kennedy engineering director, said.

"I think the Feb. 15 launch target will

be extremely difficult and we probably will not make it," USAF Lt. Gen. Forrest S. McCartney, Kennedy director, said. "We have a schedule, but other than as a management tool it's not that important. Our biggest single challenge is to see that all the safety implications are considered."

A significant revision in Kennedy's shuttle processing contract with Lockheed is indicative of that commitment to safety, McCartney said. Prior to the Challenger accident, fees to Lockheed were awarded based on cost and schedule performance. The contract has been modified since the accident to provide fees based on quality performance, he said.

The reversion or rewriting of Kennedy procedures is only about 25% complete and constitutes a major effort here, Sick said.

Formal retraining of the launch team is another major effort. Previously launch personnel received on-the-job training and progressed as their experience increased. Now, however, that training will be far more structured, with a standards board and certification review, in effect, to license all launch personnel here, Sick said.

Launch simulations already are under way and being increased.

Full shuttle countdown simulations with an integrated launch team involving about 150 people are being conducted in the Kennedy Launch Control Center twice a month. Smaller training simulations are held more often.

Sick said Kennedy is about to ask for



industry proposals for a full shuttle launch countdown simulation system.

During real countdowns, the polling of controllers for status when problems are being addressed will be much more formal than in the past. Multiple managers will formally review any issues where earlier that would have been done more informally, Sick said. This will require more time and documentation.

Any significant issues arising after T-5 min. will "force an automatic scrub," Thomas said. This is because auxiliary power unit hold times after T-5 min. often would be exceeded by the amount of time necessary to discuss a technical issue at this point under the more formal process.

Charles D. Gay, director of shuttle management and operations here, said he hoped defining clear lines of responsibility will help counter countdown delays, but also believes they will be more numerous.

Extensive procedure changes and hardware additions also are being worked here to improve weather forecasting for shuttle launches. This will involve especially wind shear detection, a factor raised in the Challenger accident.

A larger number of advanced aircraft and ground systems will be added as part of the weather improvements.

In the area of landing safety, Kennedy's runway will receive barriers capable of stopping an orbiter traveling at 100 kt.

Two additional slide wire launch tower escape baskets will be installed and the orbiter access arm paths of escape will be

Technicians at Kennedy Space Center work in the nose landing gear well of the orbiter Columbia (opposite page), preparing the area for a modified thermal barrier. The orbiter's orbital maneuvering system pod with its 6,000-lb.-thrust engine is towed to a Kennedy storage facility (above). Smaller thrusters in the pod have been removed for modification. Columbia's main engine oxygen and hydrogen lines are inspected by a technician sitting among the plumbing in the orbiter's external tank (below). The orbiter's liquid oxygen fill and drain lines are the structure at center. Kennedy technicians have pulled the valve assemblies below these lines that lead to the shuttle external tank because of valve concerns.



American Rocket Negotiating For Suborbital Test Flight Of Hybrid Launch Vehicle

By MICHAEL A. DORNHEIM

Los Angeles—American Rocket Co. has started negotiations with Air Force officials to make a suborbital test flight of the company's hybrid rocket engine from Vandenberg AFB, Calif., possibly by the end of the year (AW&ST Feb. 23, p. 39).

Amroc is changing development plans to accommodate the suborbital test, which is to lead to later orbital flights.

Initial Agreement

The Air Force is supportive of Amroc's efforts and initial agreement has been reached on range safety methods, orbital parameters and communications frequencies. A difficult choice will be determining which of several abandoned launch pads to use—the main concern being what is near the rocket's flight path in case the test goes awry.

Launch pad siting at Vandenberg has become more of an issue since a Titan 34D booster blew up there last Apr. 18 not far from the \$3.2-billion SLC-6 space shuttle launch complex (AW&ST Apr. 28, 1986, p. 16). SLC-6 is at the south end of

armored against heat to protect astronauts from fire if they must flee during a pad emergency.

Thomas has put all Kennedy safety personnel under a single directorate with safety in one office and quality and reliability in another. The emphasis will be on providing an independent flight safety launch assessment.

The office is receiving about one additional safety issue to study every day, and has asked for an extra 55 personnel to handle the workload.

A safety reporting system that will guarantee anonymity to individuals with concerns is being instituted.

"What I want to do is get a work force that has the most up-to-date, complete and comprehensive set of maintenance instructions on how to do what they need to do," McCartney said.

"We will have a great amount of emphasis on comprehensive documentation," he said. "Our paperwork needs to be more disciplined—any error is unacceptable."

"The reason I am so heavy on documentation is because we do not have any real record of what we've got in the hardware except for the paperwork. If you can not trust the paperwork and it does not reflect the vehicle configuration, then I do not know how you make a good risk assessment about whether you are ready to fly." □

struction, but not all flight-weight plumbing and hardware.

■ Three flight modules with all flight-weight components, including liquid oxygen tank and plumbing.

The injector failure on Dec. 12 is believed to have been caused by a temporary aluminum restrictor in the liquid oxygen flow about 1 ft. outside the engine that was being used because the throttle valve pintle had broken during cold flow tests. Radiant heat from inside the engine is believed to have melted and then ignited the aluminum, which then ignited the downstream stainless steel oxidizer plumbing.

Failure of the silica and glass phenolic ablative exhaust nozzle is believed due to generally oxygen-rich exhaust gases, caused by the lower-than-expected fuel vaporization rate, and aggravated by an increase in liquid oxygen flow as the aluminum restrictor melted.

The Rocket Propulsion Laboratory is letting Amroc use an old Thor missile test stand as part of the government's effort to commercialize the space launch industry, and the company moved in last April (AW&ST June 16, 1985, p. 20). Amroc pays for utilities and Air Force services such as lifting cranes. A prime potential Amroc customer is the Air Force.

The company's Industrial Launch Vehicle design uses 19 flight modules in four stages to place 4,000 lb. into a 135-stat.-mi., 28.5-deg. inclination orbit, or 3,000 lb. into a 135-stat.-mi. polar orbit (AW&ST Sept. 29, 1986, p. 18).

Amroc President George A. Koopman quoted a price of \$8 million per launch and said the company would be ready to take orders this spring.

The hybrid rocket is simpler and cheaper than a liquid engine, and the hybrid fuel is safer than conventional fuel/oxidizer mixes. This means the hybrid is not treated like a high explosive and hence is much cheaper to produce, transport and operate. The fuel is cast at Amroc's Menlo Park, Calif., plant.

Launch Abort

The hybrid also offers the advantage over a conventional solid in that it can be throttled with the oxidizer flow. This allows a launch to be aborted on the pad if all 12 first-stage engines are not working correctly, and allows in-flight throttling for steering and to reduce maximum g-forces and aerodynamic loads. Expected hybrid specific impulse of more than 300 sec. compares with 455 sec. for the space shuttle liquid-fueled main engine and about 285 sec. for a conventional solid motor.

However, with the separate high-pressure liquid oxygen tanks and plumbing, and the large amount of empty space cast in the fuel for passage of the oxidizer gas, the hybrid is heavy, resulting in an esti-

Vandenberg and all rockets launched south into polar orbit pass near it.

Amroc's suborbital test flight would go west over the ocean, but the company hopes later to fire its proposed Industrial Launch Vehicle (ILV) over polar orbits from Vandenberg, where overflight of active launch complexes would be more of a concern.

Amroc has begun testing a second full-scale prototype hybrid engine at the Air Force Rocket Propulsion Laboratory at Edwards AFB, Calif., following two tests on its first prototype there last December (AW&ST Dec. 22, 1986, p. 30).

The tests are collecting basic data and checking performance of liquid oxygen injectors.

The hybrid rocket uses solid fuel in combination with a throttleable liquid oxidizer that allows thrust to be varied and the engine to be turned on and off. Several channels cast into the fuel allow the oxidizer, which is injected at the top of the motor, to run the length of the case for proper combustion.

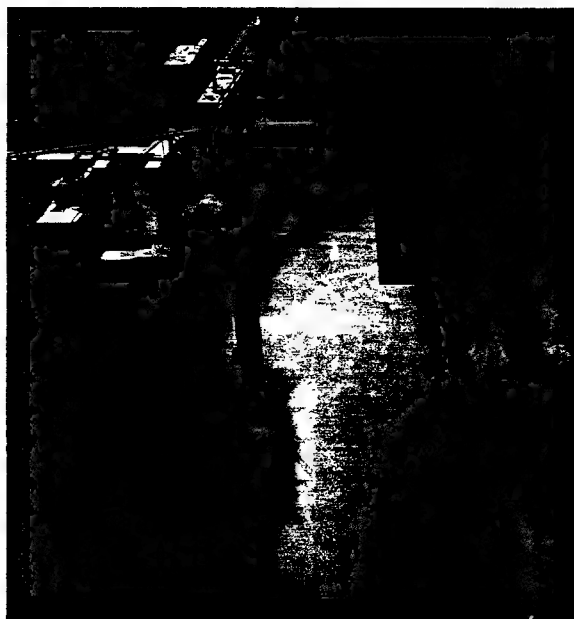
Amroc's design primarily uses polybutadiene rubber fuel and liquid oxygen. Chamber pressure is fairly low at several hundred psi, so liquid oxygen can be fed with gas pressure instead of mechanical pumps.

Motors are about 40 in. in dia. and will be loaded with 3,000 lb. of fuel and 8,000 lb. of oxidizer for flight. A vacuum specific impulse of more than 300 sec. is expected, and atmospheric run data are not far from this goal, according to James R. French, American Rocket engineering vice president. Design thrust is 33,500 lb. at sea level building to about 42,000 lb. at altitude.

Ground Tests

Ground tests of 11-13 engines are planned before the suborbital test, as follows:

- Three heavyweight engines made with thick steel and insulation for multiple firings to refine basic design. The first was fired Dec. 11 and 12, and the second had its first firing on Feb. 17. The second engine is testing modifications to the fuel shape, injector design and nozzle design based on results from the first engine, which ran successfully for a while but had a low fuel vaporization rate and eventually blew out the liquid oxygen injector and exhaust nozzle. The third heavyweight engine was added to the program recently to get thrust vectoring data for the suborbital flight and further refine basic design.
- Five to seven development engines with filament-wound flight-weight con-



American Rocket Co. tested its first full-scale prototype hybrid engine in an old Thor test stand at the Air Force Rocket Propulsion Laboratory last December. The test showed smooth and stable combustion with motor case vibration averaging several g's, comparable to an all-liquid engine. Further tests on a second engine are under way.

Return Capsule

The company is working with General Electric on using a GE payload return capsule.

American Rocket also sees Strategic Defense Initiative targets and payloads as a market and has hired SDI experimenter Michael D. Griffin (AW&ST Dec. 8, 1986, p. 20). The ILV also may be used to launch fuel and other consumables for on-orbit replenishment, a scheme that Koopman was involved with in the now-defunct Orbital Power and Light Co. □

OSC Offers to Finance Titan 34D for Mars Observer

Washington—Orbital Sciences Corp. has offered to finance the purchase of a Mars Observer Titan 34D on which NASA could launch the Mars Observer in 1990. The proposal would allow NASA to reverse its plan to delay the mission until a 1992 shuttle flight, a move prompted by the backlog of planetary missions resulting from the Challenger accident.

Orbital Sciences placed a \$100,000 deposit with Martin Marietta Mar. 13 to reserve a 1990 launch. OSC officials hope to win NASA approval in April to sign a Titan contract by June for the Mars mission. The company proposed the financing arrangement after NASA issued a statement Mar. 13 that it would not change its plans to delay the Mars Observer until 1992. Scientists, members of Congress and some members of the general public had urged NASA to hold the 1990 date by transferring the mission to an expendable launch vehicle.

NASA issued the statement after it received word from the Air Force that a Titan 3 could be provided only if NASA came up with money this year to pay for it. NASA and the Air Force are working out an arrangement for exchange of launch vehicle services that will not require payment until one year before launch. However, that quid pro quo agreement has not

yet been signed, and cannot be used in Fiscal 1987-88 because the Air Force budget does not contain extra funds to provide startup money for NASA ELVs.

Orbital Sciences is supplying the Mars mission with a Transfer Orbit Stage (TOS) booster, and company officials would like to help maintain the earlier launch date to provide an early demonstration of TOS capability. OSC proposes to earn no profit on the financing arrangement, but would recover the costs of arranging the program and also charge an amount to cover a limited return to investors and pay for interest on debt that would be used to finance the Titan.

The company would use a combination of debt and equity investment funding to finance the Titan. It is expected that 60-70% of the funding would come from debt financing, with the Titan being used as collateral to secure a short-term loan at an interest rate of about 9%. The remainder of the funds would be taken from an equity investment offering that OSC has been planning for later this year. The expected payment from NASA in Fiscal 1989 would be used to repay the loan and its interest and provide the investors with some financial return.

Under the proposal, NASA would not need to make any commitment to OSC

until October, 1988, when the Fiscal 1989 budget would take effect. At that time, NASA would repay OSC for the financing program and take over payments for the Mars Titan, or opt not to proceed with the Titan launch. If NASA did not proceed, OSC would attempt to recover its investment by selling the Titan to another user.

Space agency officials are reviewing the OSC proposal. Philip E. Culbertson, NASA associate administrator for policy and planning, said the proposal is being examined for its cost and budget impact, legal considerations and procurement implications. "We have not set a deadline for responding, but we are expediting the review," he said. No previous unsolicited proposals have established a precedent that could be applied, nor does NASA have much experience in working with unsolicited proposals that involve deferred payment plans, he said.

NASA is under some pressure to make a quick decision because if the offer is accepted, minor modifications would be needed to the Mars Observer and the TOS guidance system. If NASA accepts, it would need to request Titan 3 funding, plus additional money for OSC's administration costs and interest, in the Fiscal 1989 budget. Titan 3 prices are expected to be \$110-140 million each. □

Commerce Dept. Will Buy ELVs From Private Sector

Washington—Commerce Dept.'s National Oceanic and Atmospheric Administration has notified NASA that Commerce will buy commercial expendable launch vehicles for three launches directly from the private sector, and that NASA will no longer be used as NOAA's procurement agent.

Thomas N. Pyle, NOAA assistant administrator for environmental satellite, data and information services, said in a Mar. 2 letter to NASA, "The Dept. of Commerce has made a policy decision that Commerce/NOAA should conduct this procurement for ELV-based launch services... We would welcome having NASA technical staff participate in the evaluation of proposals and in the follow-on contract monitoring."

NASA had prepared a solicitation for three launch vehicles and was planning to issue it from Lewis Research Center, where the program would have been managed (ENR Jan. 19, p. 24). NASA officials last week "were drafting a re-

sponse to the letter and were considering turning down the request for technical assistance. NASA was expected to adopt the position that unless it serves as agent for the launch procurement with full responsibility, it does not want to be involved because if there is a failure, NASA would be blamed, even though it had no control of the program.

NASA officials cite the problems associated with launching a \$100-million government satellite on a \$40-million commercial booster with no insurance and very limited oversight of the manufacturing and launch process.

The situation illustrates the comparative benefits and drawbacks of commercial versus government launch programs. Commerce Dept. officials have argued that commercial expendables are cheaper because of the lack of government involvement in production and program management. NASA officials agree, but point out that the government does not insure its payloads, as commercial satellite owners do, and there-

General Dynamics Cites Launch Candidates for Atlas G/Centaur

San Diego—General Dynamics has identified 45 satellites as high-priority objectives in its renewed marketing campaign for commercial launches between 1989 and 1994 with an Atlas G/Centaur, which will have a payload fairing sized to accommodate space shuttle and Ariane 4-class payloads.

The company is talking to 10 potential customers about possible launch of about 15 spacecraft during the five-year period, Alan M. Lovelace, general manager of General Dynamics' space systems division, said. Nearly all of the satellites are communications spacecraft, and about 70% are domestic payloads.

General Dynamics' market projections show there are 27 firm payloads to be launched during the five-year period in the payload weight class of the Atlas G/Centaur—3,500-5,200 lb. to geosynchronous transfer orbit.

In addition to the 27 firm spacecraft, there are an estimated 22 additional satellites that are planned replacements for existing spacecraft and nine more that are "possible" payloads. The total of 58 satellites, uncommitted to a launch vehicle, include government satellites and domestic and international commercial payloads.

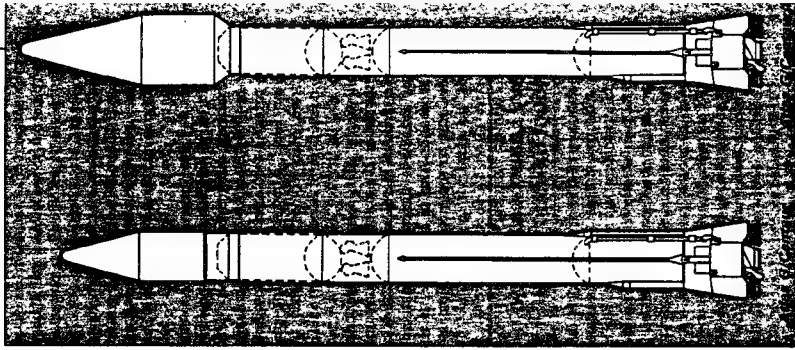
General Dynamics reevaluated the commercial launch vehicle market after the company was not selected to develop the Air Force's medium-launch vehicle (MLV). Company officials said a launch rate of three satellites per year beginning in 1989 would be an acceptable rate for the Atlas/Centaur in launches from Pad 36B at Cape Canaveral AFS, Fla.—which could support up to five launches with a surge to six launches per year.

Launch Pad 36A, which was used for development work on the shuttle-Centaur program, could be reactivated for Atlas launches as a growth option.

Lovelace said General Dynamics has received a memorandum of understanding from the Air Force which the Air Force said should enable the company to proceed with commercial launch vehicle planning and more detailed discussions with potential customers.

In addition to the Air Force commercialization program, General Dynamics expects formal approval last week of an agreement with NASA headquarters on issues such as tooling, equipment, manufacturing, financial arrangements and liability.

An ancillary agreement for launch services may be completed in April. The Atlas G/Centaur will be offered with payload fairing diameters of 10 ft., 10.8 ft. and 13.8 ft. The 10-ft. shroud is the same size as the present fairing, while the 10.8-ft. shroud has been sized to accommodate payloads and payloads designed for Ariane 2 and 3 fairing sizes.



Comparison of present General Dynamics Atlas G/Centaur launch vehicle, left, and the planned Atlas G/Centaur booster with a 13.8-ft.-dia. payload fairing is shown in drawing. The new launch vehicles, designed to boost payloads of up to 4,900 lb. to geosynchronous transfer orbit, would be available beginning in 1989.

Logica Will Manage Software Definition For Columbus Module

London—Logica, Plc., a British software company, has been selected as system software manager for Phase 2B detailed definition work on the European Space Agency's Columbus space station orbit.

The system software definition work is a newly created role in the Phase 2B segment of the Columbus program. The contract, worth approximately \$800,000, was awarded by MBB-Eno of West Germany, prime contractor to ESA for the Columbus program. Other primary subcontractors include:

- Resource module—Dornier of West Germany.
- Polar platform—British Aerospace.
- Pressurized module—Aeritalia.
- Data management—Matra of France.
- Integration and test—MBB-Eno.

Logica's systems software work will be divided into three stages. Two will consist of specification definition, and one will include some software prototyping. Specification definition will be performed for both on-board system and mission management software and for ground-based mission preparation software.

Software technology support phase will include some software prototyping. Ada will be the language most likely used for this work, although that determination has not been finally made.

Several other European software development companies are working as second and third tier contractors to Logica in the effort. These include MBB-Eno and a team led by CRT of Denmark, comprising Kampax of Denmark, Casela and GMV of Spain, Norspace of Norway and Saab-Scania of Sweden.

The contracts received by Logica and others are important not only for the direct impact they will have on the Columbus program, but also because they are creating the infrastructure for European space development over the next 50 years, according to Mike Dillon, manager of Logica's Space Station Div.

The Phase 2B program is designed to permit MBB-Eno to have the data to make a firm, fixed-price quotation to ESA for the development of Columbus. Although contracts were awarded only recently, work on most of the topic areas began in November, 1986, or earlier and is expected to be complete prior to a European ministerial meeting to decide the future of the overall program.

Although Columbus Phase 2B work is designed to be complete before the June meeting, it is probable that an interim study phase will be authorized to keep the study and development teams together if the ministerial decision is delayed. □

Soviets Consider Possible Mars Rover, Sample Return Missions

By Carole A. Shifrin

Houston—The Soviet Union is considering the possibility of launching a small rover to Mars in 1992 and a mission aimed at the return of samples from Mars as early as 1996, under an ambitious plan outlined by Soviet scientists at the 18th Lunar and Planetary Science Conference.

Valery Barsukov, director of the USSR Academy of Sciences Vernadsky Institute for Geochemistry and Analytic Chemistry, emphasized that the 1988 launch of two spacecraft to study Mars and Phobos is the only mission officially approved to date (AWST Mar. 24, 1986, p. 80). He acknowledged that schedules are subject to change. "From experience that we and you have, it is well known that the schedule of the launch could be delayed," he said.

"Yet we now believe that we can launch a large satellite carrying penetrators, balloons and maybe a small Mars rover in 1992," Barsukov said. "The large Mars rover, in that case, can be launched two years later." A mission to return samples from Mars could be launched in 1996, he said, but it is more likely to take place in 1998.

Following a Mars sample return mission, the Soviet Union may seek to return samples from a Martian moon. "Such a project already is under consideration," Barsukov said. Also in the works is an eventual plan to return samples from asteroids, he added.

Navy Launches Second Trident Ballistic Missile

Cape Canaveral—The second Trident 2 D5 development fleet ballistic missile was launched here Mar. 17 from a flat pad, following a series of delays caused by ground computer software problems.

Liftoff had been scheduled for 9 a.m. EST Mar. 16 but the Lockheed Missiles & Space Co. crew was unable to launch the missile before the window closed at 2 p.m. Launch the following day came 55 min. after the window opened at 11:30 a.m. The Navy said the test was successful. There are 20 Trident missiles available for flat pad launches and 5-10 for tests from submerged submarines before the weapon is deployed on the SSBN Tennessee in December, 1989.

The first D5 launch occurred Jan. 15 at which time Cape Canaveral was besieged by antinuclear protesters (AWST Jan. 19, p. 29).

The large satellite under discussion for launch about 1992 will carry a number of instruments in its scientific payload—weighing 200-250 kg. (440-550 lb.). The payload includes optical, radar and spectroanalysis equipment as well as instruments able to penetrate the surface of Mars. The mission will study the chemical and meteorological composition of the Mars surface, do thermal mapping of the surface with a 3-km. (1.9-mi.) resolution, and take high-resolution (10-meter) images with a television camera, among other efforts.

Landing Module

The 1992 mission also will include the landing of a module containing two penetrators and one balloon on the surface of Mars. The double-shell balloon carrying one of the penetrators will fly over the surface of Mars no higher than 6 km. (3.7 mi.) during the day when the sun heats the balloon, obtaining high-resolution images. When it lands at night it will measure the chemical composition of the surface at the landing site, Barsukov said. The penetrator will try to dig through the oxidizing zone to determine chemical composition of the material beneath it and whether there is any organic material. Orbiter payload equipment would include a synthetic aperture radar, one American scientist noted.

Barsukov said the Soviets also are designing a small Mars rover for possible landing during the 1992 mission. That would be followed by launch of a large Mars rover two years later, which would be used to go longer distances.

During the 1994 mission, the Soviets plan to use two automatic robot moles that could penetrate down into the soil 20-30 meters (66-98 ft.), Barsukov said. One of the moles would bear instruments for chemical analysis of the material while the other probably will try to determine whether there is biological activity.

"We are now discussing the possibility of drilling and sampling at different stations of the route," he said, with the additional possibility of taking some samples on board the rover for more detailed study.

The following sample return mission from Mars is being discussed "together with our French colleagues," Barsukov said.

It would be difficult to predict when a manned mission might be considered, according to Barsukov. To travel to Mars and return would take 2.5 years, he said, while the longest a cosmonaut has spent in space is about one year. "When our

cosmonauts fly around the Earth as long as three years, then let's decide whether to fly to Mars," he said.

At another session, Lew Allen, Jr., director of Jet Propulsion Laboratory, said a major new initiative, likely focusing on human exploration of Mars, would rejuvenate NASA and restore its budget for additional and complementary programs. According to Allen, President Reagan may be asked soon to support such a venture (AWST Mar. 16, p. 24).

"I believe that [NASA Administrator James C.] Fletcher is convinced that now is the time for him to very carefully consider and to discuss with the President a bold new initiative for NASA, one that will in fact break out of this restrained and deficient track that NASA is on," he said.

Allen said Fletcher was very conscious of the fact that the Fiscal 1988 budget request was inadequate because it provided only some necessary items and not others that have not yet been satisfactorily defined. Nor did it provide much in the way of new directions for NASA, he said.

Allen cited the space station science program and Earth and ocean sciences as areas in which there are sound programs that are not adequately budgeted. "It is clear that to do the sound plan that

NASA already has, at a reasonable pace, would require a very substantial increase in the NASA budget, perhaps as much as 50%," he said. "But that seems somewhat unlikely, under the kind of budget pressures that existed in the past."

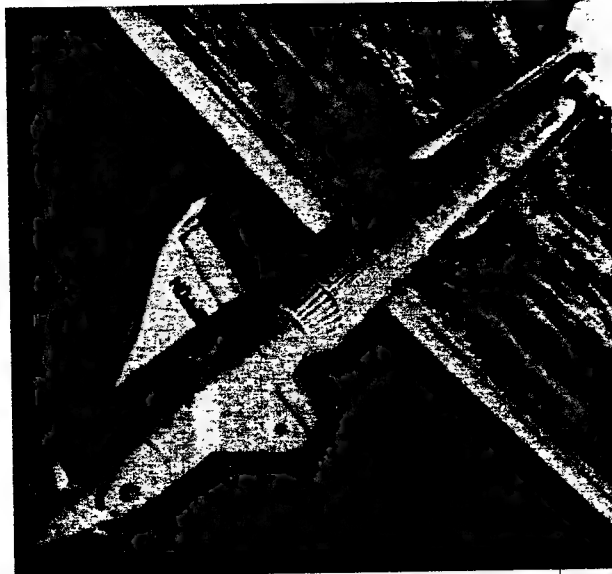
Geoffrey A. Briggs, director of NASA's solar system exploration division, said the agency had put on hold a decision announced Mar. 13 to delay launch of the Mars Observer mission to 1992. NASA had confirmed that its Fiscal 1988 budget plan did not include a request for funds to launch the Mars Observer in 1990 as earlier planned.

"There has been a reprieve of a couple of weeks to rethink the matter, and to consider some new information and the possibility of getting a launch vehicle," Briggs said. He added that the agency was looking at ways to find a Titan launch vehicle that could place less burden on the 1987-88 budgets, which are relatively fixed. "But it isn't all over just yet and we'll see what happens."

One reason for "turning up the heat on Mars," he said, was recognition of the fact that the Soviets have embarked on a major Mars program. "It's clear to me that we shouldn't plan on leaving the inner solar system—and Mars in particular—to our colleagues to explore," he said. □

Japanese Examine Spaceplane Shuttle Concepts

Japanese spaceplane shuttle is launched from Tanegashima Island atop an H-2 heavy booster in this artist's concept. The concept is one of several that the National Space Development Agency, the Institute of Space and Astronautical Sciences and the National Aerospace Laboratories are examining for operations early in the 21st century. In addition to Japan, the Soviet Union, European Space Agency, Germany and Great Britain all are examining shuttle/spaceplane vehicles for operations in the late 1990s. The first launch of the H-2 booster is set for 1992.



NASA May Be Forced to Take Minor Role in Heavy Launcher

By Theresa M. Foley

Washington—NASA may be relegated to a relatively minor role in the Heavy-Lift Launch Vehicle as a result of recent Air Force action to assign responsibilities for the program, according to contractors pursuing HLLV business.

Some members of Congress believe the strong Air Force and relatively weak NASA roles in the HLLV indicate a continuing shift in U.S. space policy toward military uses of space.

A recent letter from Air Force Secretary Edward C. Aldridge to NASA Deputy Administrator Dale D. Myers asked that NASA requirements for a heavy booster be defined quickly and that the agency propose how its expertise can best support the project.

Aldridge suggested that NASA assign "experts to the office at the Air Force's Space Div. [headquarters] to provide liaison with contributing NASA centers, and to ensure that NASA requirements have been recognized." Industry officials involved with the HLLV said they interpreted the language to mean that the Air Force did not want extensive NASA involvement in the program. "They've basically told NASA to send some experts, then get lost," an industry official said.

NASA's requirements for an HLLV are expected to center on space station assembly and advanced planetary exploration missions.

The lack of extensive NASA involvement in the HLLV reflects the shrinking importance of the civilian space program compared with the defense space budget, according to some officials. Some members of the Senate Commerce subcommittee on science, space and technology said NASA should play a much stronger HLLV role.

GAO Report

A General Accounting Office report released by the subcommittee Mar. 5 said military space expenditures at \$17 billion in Fiscal 1987 greatly exceed the NASA space budget of \$8 billion. NASA spending gradually increased from \$5 billion in 1981 to \$6.9 billion in 1985, at the same time the Defense space budget skyrocketed from \$4.8 billion to \$12.8 billion, the report said. The GAO report compared the two budgets from 1981, when they were about equal, to 1985, the last year that complete Defense space estimates were available.

While NASA budgets were receiving annual increases of 4-14%, the Defense space budget grew steadily at rate of 19-

36%, outpacing even overall Defense spending increases, which ranged from 8-24%.

"The Defense space program is growing at an extraordinary rate, while NASA's space program has leveled off," Sen. Donald Riegle (D-Mich.), chairman of the subcommittee, said. As further evidence of the declining status of NASA, Riegle compared the ownership of U.S. expendable launch vehicles. Of the existing ELV inventory, NASA owns 12 launchers, the Defense Dept. owns eight and two are jointly owned. But of the ELVs on order, the Defense Dept. has 43 with an option for an additional 13, while NASA has only one, he said.

SDI Increases

Aldridge defended the military space budget by saying the Defense Dept. has significantly more space operations than NASA. "A lot of that cost increase deals with rapid and necessary growth in operation and maintenance of space and launch vehicles going along with the operations in space, rather than just research and development," Aldridge told the subcommittee. He said Strategic Defense Initiative increases also have driven military space spending up sharply.

Expanded operations in command and control, communications, early warning, treaty monitoring and weather observation have contributed to the growth of the Defense space budget, he added. Other

factors driving Defense space costs up have been the increased sophistication, survivability and weight of military satellites, and increasing launch vehicle prices. "There is a growing need, a logical and explainable need, for use of space in support of military operations that did not exist in the early or late 1960s or 1970s," Aldridge said. Space is the fastest growing element of the Air Force budget, he said.

Myers, who was a senior NASA official during early shuttle development, said the space agency budget fared relatively poorly because of "disinterest" in space during the shuttle era. "I was amazed when I rejoined NASA to find how little we had continued to do in space technology, new propulsion systems, new materials—the activities that always had been so strongly supported at NASA during the Apollo program were suppressed," he said. "Every dollar they had went into the shuttle program they had to take out of NASA."

Sen. Albert Gore (D-Tenn.) said he believed that while the Air Force is the rightful leader in the National Aerospace Plane program, NASA should have the HLLV lead. Turning both developments

USAF Satellite Shows Meteorological Effect Of Nuclear Accident

Effect of the Soviet Chernobyl nuclear accident on the environment was imaged by a U.S. Air Force Defense Meteorological Satellite that photographed the area on May 2, 1986, six days after the reactor meltdown. In this photograph transmitted to Offutt AFB, Neb., radioactive ions have cut open a 150-mi.-long path through the clouds (large white arrows, center) southeast of Chernobyl. The accident site is just north of Kiev. This so-called "nuclear distal" had been predicted but never before seen, according to Henry W. Brandt, chairman of the National Weather Assn. satellite meteorology committee who analyzed the image in connection with USAF meteorologists. Ionized radioactive gases pouring from the ruptured reactor have reacted chemically with water vapor in the area to dissipate the clouds along the 30-mi.-wide strip. The nuclear distal shows that in addition to pouring radioactive ions into the air affecting local weather, nuclear material also was picked up and dropped elsewhere by the cold front moving northwestward through the area. Upper air flow is indicated by small black arrows while open arrows indicate low-level flow. Other features in the picture are cumulus cloud lines (Cu lines) and a cloud line shadow at top.



have any money to spare for HLLV development for many years.

Another complication for NASA is a recent White House directive that said the space agency will not maintain an ELV adjunct and that if launch capability is needed over what the shuttle provides, NASA will contract for services. The full implication of that directive is not yet known, but some government officials believe it means NASA no longer will be allowed to manage ELV programs internally. Instead, the agency must turn to commercial firms for ELV launch capability, they said. Riegle said the directive is placed "in a fairly tight straitjacket, and that we're seeing a major shift in space policy to the military."

Aldridge told the subcommittee that HLLV management should remain in the Air Force because the requirement for the booster is dominated by military needs. "That's where the money's got to come from. We have to be the lead," he said.

Details on HLLV development were described in an Air Force draft program research and development announcement

obtained by AVIATION WEEK & SPACE TECHNOLOGY. The ultimate goal of the HLLV is to lower launch costs by a factor of 10 compared with the Titan 4, which costs \$250 million and can lift 65,000 lb. to low Earth orbit from Cape Canaveral Air Force Station, Fla.

While the final HLLV concept should result in those drastic savings, contractors are expected to propose interim concepts that would reduce costs only by one-third, but be available for earlier use.

Technology Base

Strong debate continues among NASA, Air Force and Strategic Defense Initiative officials over whether the HLLV should be based on new or shuttle-derived technology. Circumstances may require the Air Force to accept a shuttle-derived concept if SDI needs the new booster by the early 1990s. Aldridge said SDI officials want the option to begin deploying a system as early as 1993 or 1994, meaning that the HLLV would be needed then. Without SDI, the Defense Dept. would not need the heavy booster until 1997. A low-cost launcher using new technology

could be available about 1997, Aldridge said. A shuttle-derived vehicle would allow earlier use, "but we know that isn't what is wanted ultimately," he said.

The Air Force HLLV announcement said, "The HLLV design should exploit currently available and emerging technologies that offer dramatic improvements in economics and efficiencies. The system should avoid the expensive legacy of labor-intensive hardware production and operational procedures to the maximum extent possible to achieve potential economies and efficiencies offered by more advanced technologies."

Air Force officials believe shuttle-derived systems are inherently expensive because the operations associated with shuttle-type launches are labor intensive. While the Air Force's chief objective is low cost, NASA's priority is to develop a high-reliability launcher. Systems launched by NASA typically are unique, expensive spacecraft, rather than operational satellite constellations, which hold at least the possibility of replacement by later vehicles in the series in the event of a launch failure. □

NASA Deputy Endorses Heavy-Lift Launch Vehicle

By Edward H. Kolcum

Senate Budget Committee hearing here called by Sen. Lawton Chiles (D-Fla.), committee chairman, Chiles said he is searching for a set of space priorities and a determination of "where we either make modest efforts in many areas, or mighty efforts in a few."

Brig. Gen. Robert R. Rankine, director of Air Force Space Systems and Command, Control and Communications, said that, with a supplemental appropriation, the Air Force could develop an initial heavy-lift launch vehicle capability in 1995-96. Without supplemental funding, this capability would take an additional five years, he said.

Mixed Fleet

Rankine said the Air Force recovery strategy from the Challenger and Titan accidents centers on development of a mixed fleet of launch vehicles with no single paths, either in vehicles or facilities, in the near term. In the far term, he said, the Air Force will strive for lower costs to put payloads into space. The objective is Myers made his comments at a special

to "ensure a more capable launch posture than before the Challenger failure."

Rankine said the 1986 accidents caused 7.3 missed launches and delayed 10 Defense Dept. payloads. The current Defense Dept. launch vehicle assets, he said, are 10 Atlases, one Delta and 10 Scout vehicles.

There are four additional Delta-assigned payloads: three belonging to the Strategic Defense Initiative Organization and one to NASA. These are to be augmented beginning in 1988 with 23 Titan 4s for 39,000 lb. payloads; 20 Delta 2 medium launch vehicles, primarily for the Navstar global positioning system, and 13 modified Titan 2s for smaller spacecraft such as meteorological satellites.

Payload capability for the new Delta 2 MLV was given as 11,400 lb. into low Earth orbit in a Cape Canaveral launch. To promote an assured access to space capability, Rankine said, dual coast launch facilities will be developed and maintained and some military satellites will be designed to fly on either the space shuttle or an expendable launch vehicle.

Rankine said the launch base strategy involves the use of two shuttle pads, a Titan 4 and a Titan 34D pad and two Delta 2 pads at Kennedy Space Center. The shuttle and Titan 34D pads are available and the others will be ready next year, he said. The Vandenberg capability is a shuttle pad, now on caretaker status, two Titan 4 pads, to become ready in 1989 and 1993, and a Titan 2 pad, to be active next year.

Commercial Space Backing

Rankine said the Air Force strongly backs commercial space launches because they make space both more accessible and more affordable. He said the Air Force is encouraging the commercial use of the Delta 2 medium-launch vehicle and is allowing use of Defense Dept. facilities on a direct cost basis. Recoupment of development costs is being waived.

Far-term space transportation alternatives are being analyzed under a \$24-million architecture study funded by NASA, Air Force and the Strategic Defense Initiative Organization. Boeing and Rockwell are assisting the military, and Martin Marietta and General Dynamics hold NASA contracts for the 26-month study, called Space Transportation Architecture (STA) Study, that ends in November.

Rankine said the contractors have been analyzing all aspects of space launch, including requirements, vehicles, ground operations, payload processing, logistics and manufacturing processes.

Norman R. Augustine, president and

Construction of New Orbiter At Vandenberg Assessed

Palmdale, Calif.—Moving construction of the fourth space shuttle orbiter from Palmdale to Vandenberg AFB, Calif., could jeopardize safety, incur considerable additional costs and affect flight schedules, according to assessments of local aerospace-oriented area around Palmdale. Reduction of mission risk and increased space and civic leaders here.

At Air Force request, NASA required that all bidders responding to an orbiter construction request for proposals (RFP) study the feasibility of transferring construction to the Vandenberg AFB launch site. Rockwell International—the only firm that responded to the RFP—is completing an evaluation of the two candidate sites and is scheduled to submit its findings to NASA by mid-April (Aerospace Mar. 9, p. 269).

A NASA decision to build the orbiter at Palmdale—where all previous shuttle orbiters were assembled—or transfer the task to Vandenberg is expected 6-8 weeks later. Air Force officials have suggested that moving orbiter construction to Vandenberg could delay some costs associated with maintaining the shuttle support facility there until launch activity resumes in the early 1990s.

The site was relegated to caretaker status after the Challenger accident. Palmdale officials, while acknowledging concern over losing an estimated 1,500 local aerospace jobs if the orbiter is built at Vandenberg, also have questioned the safety and economic implications of new tooling and other equipment to the coastal site, rewriting facility-specific procedures and training an inexperienced workforce.

Preliminary estimates indicate the move to Vandenberg AFB could add \$60 million to the cost of orbiter construction. Further, an informal United Auto Workers Union poll of 150 aerospace technicians who had built the previous four orbiters indicated only 5% of the experienced

workforce would consider moving to the Vandenberg area.

They noted that, once shuttle orbiter construction was completed, follow-on employment was more probable in the aerospace-oriented area around Palmdale. Reduction of mission risk and increased space and civic leaders here.

At Air Force request, NASA required that all bidders responding to an orbiter construction request for proposals (RFP) study the feasibility of transferring construction to the Vandenberg AFB launch site. Rockwell International—the only firm that responded to the RFP—is completing an evaluation of the two candidate sites and is scheduled to submit its findings to NASA by mid-April (Aerospace Mar. 9, p. 269).

A NASA decision to build the orbiter at Palmdale—where all previous shuttle orbiters were assembled—or transfer the task to Vandenberg is expected 6-8 weeks later. Air Force officials have suggested that moving orbiter construction to Vandenberg could delay some costs associated with maintaining the shuttle support facility there until launch activity resumes in the early 1990s.

The site was relegated to caretaker status after the Challenger accident. Palmdale officials, while acknowledging concern over losing an estimated 1,500 local aerospace jobs if the orbiter is built at Vandenberg, also have questioned the safety and economic implications of new tooling and other equipment to the coastal site, rewriting facility-specific procedures and training an inexperienced workforce.

Preliminary estimates indicate the move to Vandenberg AFB could add \$60 million to the cost of orbiter construction. Further, an informal United Auto Workers Union poll of 150 aerospace technicians who had built the previous four orbiters indicated only 5% of the experienced

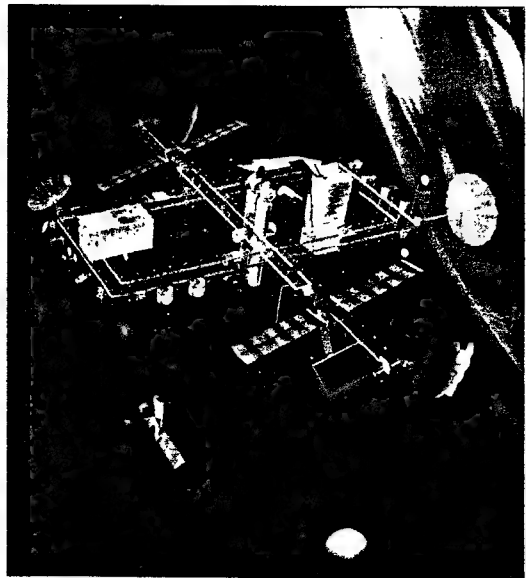
workforce would consider moving to the Vandenberg area. They noted that, once shuttle orbiter construction was completed, follow-on employment was more probable in the aerospace-oriented area around Palmdale. Reduction of mission risk and increased space and civic leaders here.

expendable launch vehicle—Precision recovery system.

■ Partially reusable cargo vehicle—Automated software generation, computer integrated manufacturing, robust thermal protection and precision recovery systems. ■ Manned fully reusable launch vehicles, both rocket and airbreathing systems—Automated software generation, lightweight high-temperature structures, robust thermal protection and interdisciplinary analyses.

■ Space-based orbit transfer vehicles—Automated software generation, computer integrated manufacturing, teleoperations and remote servicing, aerobraking and cryogenic fluid management. □

Martin Simulator Tests Station Equipment

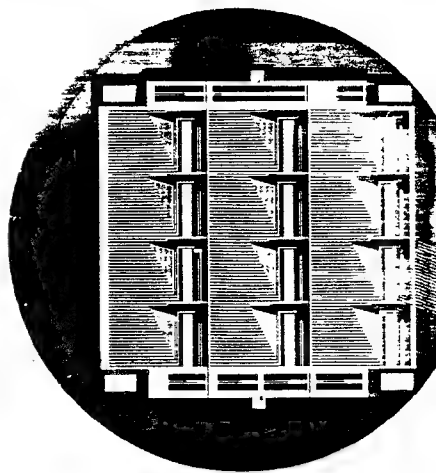


Latest version of Martin Marietta's design for a permanently manned space station is shown in artist's rendering. Unmanned free-flying platform is in upper left portion, in the vicinity of the larger space station. Martin built a space station module simulator at NASA's Marshall Space Flight Center in Huntsville, Ala. to test equipment and computer software for potential use on a space station.

INSIDE TECHNOLOGY

FOUND!

A PRACTICAL WAY TO TURN OUT JOSEPHSON JUNCTION CHIPS



HOW HYPRES USES ITS ICs TO BUILD 70-GHZ SCOPES



by Samuel Weber

Josephson junctions, a technology that could hold the key to the ultimate in speed and density for electronic systems, have been tamed by tiny Hypres Inc. After defying for years every attempt to harness their potential, working Josephson

junction circuits are not only being turned out by the Elmsford, N. Y., company, but it is using those circuits as the heart of a new, blazingly fast instrumentation work station. The start-up company apparently is on the verge of success in a field where it has eluded such giants as IBM Corp., which has largely abandoned its efforts after spending many years and many millions, and the Japanese, who are mounting a major effort as part of the Ministry of International Trade and Industry's supercomputer program.

Hypres appears to be succeeding where IBM and the Japanese have so far failed, building repeatable, reliable devices and finding a practical application for them

The Hypres work station is the PSP-1000 Pico-second Signal Processor (see fig. 1). Operating as a digital sampling oscilloscope, the PSP-1000 far outstrips any of its competitors, exhibiting a system rise time of 5 ps, a sensitivity of 50 μ V, and a bandwidth of 70 GHz. The company claims that the work station's performance specifications are five times better than those of its closest competitor.

This performance makes it possible to characterize the performance of high-speed integrated circuits and components such as emitter-coupled logic or gallium arsenide ICs. For time-domain reflectometry, the PSP-1000 brings to bear a built-in 5-ps step generator and resolution of up to 1.6 mm when measuring the reflections of wideband transmission paths.

The work station's performance requires the blinding speed of Josephson switching devices. To take advantage of that speed, Hypres had to overcome some of the most difficult and persis-

tent hurdles the technology presents. Chief among these were finding a practical way to cool the circuits to the extreme low temperatures necessary for the Josephson junction parts to work, and the task of producing dependable circuits that could be reliably reproduced.

Hypres solved the first problem by developing a new approach to cooling Josephson junction devices—one that eliminates much of the cumbersome equipment and complex procedure that had been needed to keep Josephson junction circuits at the temperatures required to make them function. The Josephson circuitry is all located at one corner of the chip; the rest of the chip architecture performs power operations. Only the corner that holds the logic is cooled. The cooling is done by spraying the circuitry with liquid helium, rather than by immersing the entire device in the helium.

The second obstacle was surmounted by making the circuits with niobium, rather than with lead and its alloys, which have turned out to be brittle and unreliable. Doing so allowed the company to produce reliable, repeatable Josephson junction circuits—something that IBM, which used lead and lead alloys, was never able to do, according to Sadeg M. Faris, Hypres's president and a former IBM staff member.

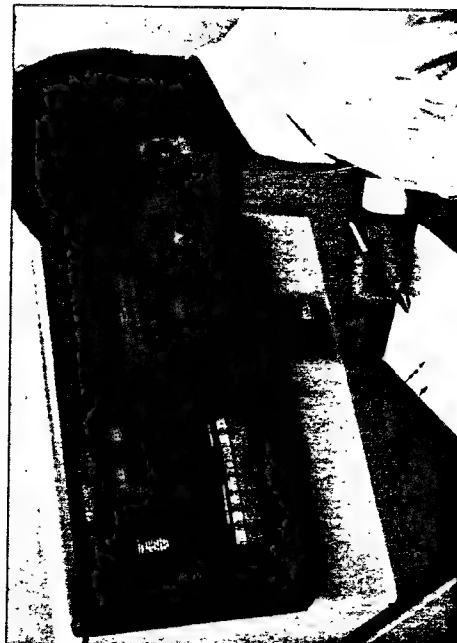
Measured against the goals of IBM and the Japanese, the PSP-1000 represents a relatively small-scale application of Josephson junction technology. But the successful use of superconducting electronic technology in the system has far-reaching implications.

It could be the first step toward using the devices to build compact but extremely powerful supercomputers. It also could foreshadow Josephson junction technology for a range of important applications—millimeter-wave communications, subnanosecond digital processing, and analog signal processing, and high-precision analog-to-digital conversion. The potential for such applications has spurred the ongoing Josephson junction research projects around the world (see p. 54).

Hypres deliberately chose, however, to apply the technology first to a manageable project. Faris says he felt such an approach was vital to Hypres's success—that one reason other projects have failed is that they have been geared toward large-scale applications, forcing the researchers in those projects to attempt to do too much (see p. 53).

Applying the technology to even the simplest system poses enough

1. PICOSECOND PROCESSOR. Based on Josephson junction technology, Hypres's new work station can capture and analyze waveforms with rise times of less than 10 ps.



problems for a designer. Josephson junction devices must operate at near-liquid-helium temperature (4.2 K). The available refrigeration equipment is bulky and inconvenient to use, and it is extremely difficult to transmit wideband signals without significant thermal loss between cryogenic regions of the circuitry and warmer, external areas. The usual methods have been either to immerse the components in liquid helium or to thermally ground the circuit to a cold "finger" while the circuit itself was sealed in a vacuum. Both arrangements required an hour or more to change the sample and allow it to reach the desired cold temperature.

In the Hypres design, the Josephson junction circuits are situated at one corner of the chip, and that corner is cooled to superconducting temperature. The other edges, only a half centimeter away, are held at room temperature (see fig. 2). Instead of cooling the entire chip, a tiny jet of liquid helium from a small reservoir within the proprietary cooling system sprays only the active Josephson junction circuit area.

The active Josephson devices are fabricated in a niobium alloy, the use of which overcomes the problem of failure with cycling encountered when lead and its alloys are used. The circuitry is formed on a fused silica substrate. A coplanar waveguide transmission line links the circuit area to the backside of the wideband coaxial connector to which it is bonded. Low-speed bias and control lines are arrayed across the top of the chip and contact is made via a flexible Kapton substrate.

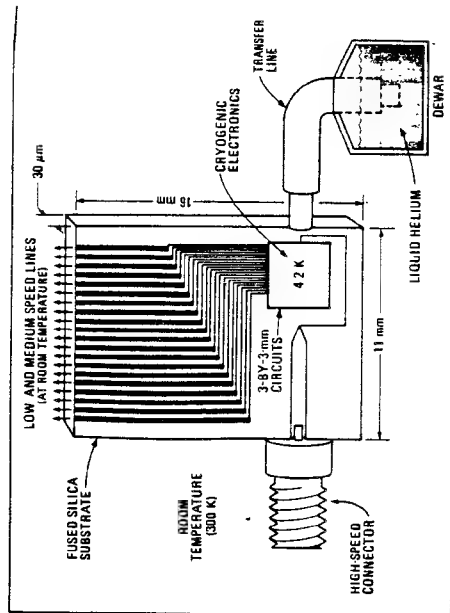
The arrangement gives the user access to the high-speed connector interface without any evidence that a cryogenic environment exists less than a centimeter behind the connector. The cryogenic circuitry consists of a step generator, strobe pulse generator, sampling gate, and electrical delay, all of which are implemented in Josephson junction technology.

The process used by Hypres employs three layers of differing sheet resistivity to form three levels of resistors, and two metal layers for interconnections (see fig. 3). The chip is produced using a con-

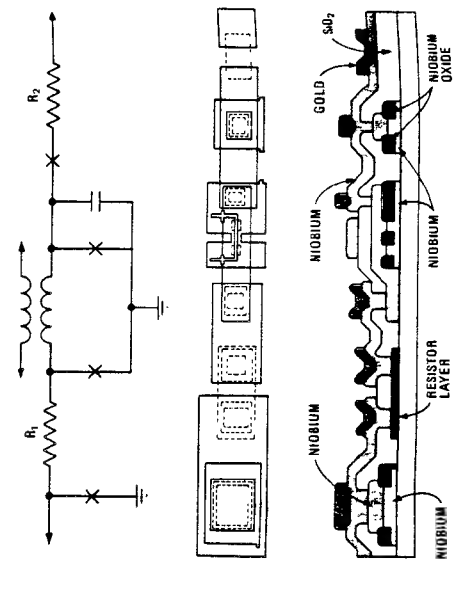
2. LAYING IT DOWN. The Hypres process implements the schematic at right by sputtering and reactive ion etching of thin-film layers of oxides and niobium.

servative 3- μ m geometry on a fused quartz substrate. Because Josephson junction devices are a thin-film technology and don't depend on crystal line substrates, the process can produce complex circuits on inexpensive wafers, Faris says.

"With our process and our conservative design rules, we didn't need to use a lot of expensive equipment to produce devices that can maintain highly uniform switching thresholds across the entire wafer, achieving very high yields," he says. "What's more, we'll be able to extend the process to submicron geometries inexpensively, with the capability of integrating—on one relatively inexpensive substrate [glass]—sensors, memory, and digital and analog processors,



3. COOL IT. Cooled by a controlled jet spray of liquid helium, the Josephson junction circuit kept constantly superconducting while interfacing with room-temperature electronics



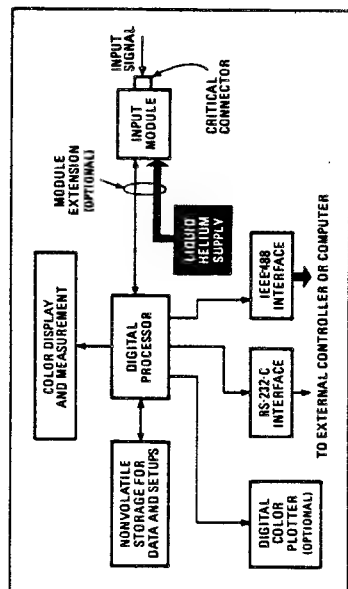
2. LAYING IT DOWN. The Hypres process implements the schematic at right by sputtering and reactive ion etching of thin-film layers of oxides and niobium.

which could open up the way to true wafer-scale integration."

In the PSP-1000, the superconducting chip is mounted in a plug-in, modular, online-replaceable measurement head. The process of changing a head takes less than a minute. Various configurations, including a dual-channel version, are available for different types of measurement samples. Each head also includes a high-speed interface and connector, a printed circuit board and the necessary cryogenic components.

The head takes only 10 minutes or so to cool to operating temperature when the work station is first turned on. When a new measurement head is installed, it comes to operating temperature within two minutes.

Cooling is provided by a helium reservoir in a dewar container mounted inside the console. It gives up to 12 continuous hours of operation or a combination of up to eight hours of continuous operation plus 16 hours of holding without heli-



4. POWERFUL PROCESSOR. The system, shown here in a single channel input version, can be configured by various options to fit the application.

um refill. Automatic controls prevent excessive helium consumption by turning off the cooling system when the instrument is idle for more than five minutes.

The PSP-1000 itself is a fully stand-alone digital instrument that provides waveform processing and storage, powerful easy-to-use measurement and set-up aids and a high-resolution color display (see fig. 4). It consists of a \$120,000 mainframe, which is configured to specific applications by the use of various input modules; these range in price from \$20,000 to \$45,000. It can be configured as a single- or dual-channel sampling oscilloscope or as a time-domain reflectometer, or it can be used in time-domain transmission measurements.

Up to four waveforms can be displayed simultaneously, each annotated in a matching color. All user controls are menu-driven. Each major function is assigned to a dedicated pushbutton, which calls up the desired menu. A maximum of eight soft keys associated with the menus are

displayed. The user can enter or change any parameter, value, or text by selecting the appropriate soft key and inputting the desired character via the alphanumeric keys or by selecting the appropriate toggle.

A nonvolatile main memory provides storage for as many as nine waveforms with a resolution of up to 1,024 points per waveform. It can also store nine sets of calibration and setup data.

The user can enter his own formulas to operate on any waveform to present data in the most meaningful form. Built-in operations include fast Fourier transforms, multiply, divide, integrate, and differentiate functions. Two vertical and two horizontal markers facilitate accurate reading of waveform features. Portions of the waveform within either the x or y markers can be magnified for easier viewing.

Each channel in the PSP-1000 can have its own independent time base and can be triggered from its own signal. Alternatively, the two channels can be synchronized via a user-supplied external, independent pretrigger.

The horizontal deflection factor with a full scale of 10 divisions can be set from 2 ps to 1 ns/division. The vertical sensitivity ranges from 50 mV to 5 mV for input scales of 10 mV to 1 V.

Time-domain measurements give the user localized information on a device under test. For example, with time-domain techniques, the PSP-1000 can determine impedance and characterize transmission faults in millimeter-wave devices and circuits in the 50-GHz region, which is used in high-frequency radar and communications. With a time-domain-reflectionometer module, propagation delay in the order of tens of picoseconds can be measured. The TDR step pulse, with its fast 5-ps rise time, is used both for exciting reflections and to measure the transmission delay and loss.

The work station and the circuitry it uses are just the first step. Faris says Hypres is well along in developing its process so it can utilize niobium nitride, which would raise the critical threshold temperature of their Josephson junction circuits to 16°K. This could lead to more compact, closed-cycle refrigeration systems that would not require the handling of costly liquid helium. And the recent reports of new refractory materials that move the threshold temperatures even higher [Electronics, Jan. 22, 1987, p. 37] has him enthusiastic about the future prospects of superconducting electronics.

TECHNOLOGY TO WATCH is a regular feature of Electronics that provides readers with exclusive, in-depth reports on important technical innovations from companies around the world. It covers significant technology, processes, and developments incorporated in major new products.

FitsatCom Lost When Atlas Centaur Launch Falls

Cape Canaveral—An Atlas Centaur launch vehicle with a FitsatCom communications spacecraft payload was destroyed by range safety officers 51 sec after launch Mar. 26 when it pitched over and stopped transmitting telemetry.

The vehicle was launched in a steady downpour under a 2,500-ft. ceiling with lightning nearby. Less than 1 min into the flight, the rocket went into a hard right maneuver to a southerly heading, sending a negative indication from its axial accelerometer. Ground tracking stations were receiving telemetry data until the spacecraft was destroyed. Engine performance data appeared satisfactory up to the point the data stopped. A little more data was received from Centaur telemetry after destruction of the rocket. Telemetry was lost when the vehicle had reached an altitude of 14,250 ft., 0.5 sec downrange.

Although cloud cover was thick, a bolt of lightning could be seen in the direction of the launch, pad about 40 sec after first-stage ignition.

NASA last week formed a board of inquiry to investigate the failure.

John W. Gibb of NASA Lewis Research Center, manager of the Atlas Centaur project office, said that the launch was conducted without violating flight rules. There is a possibility that the payload was not properly secured.

The last Atlas Centaur failure occurred June 26, 1984, 99 sec before mission. There have been 67 Atlas Centaur launches since the program began in May, 1962, including seven research and development flights. Of the 60 operational missions, 54 have been successful.

Capt. John W. Albrecht of the USAF Space Div., deputy for the Head Satellite Communications Systems, said that although the launch was conducted without violating flight rules, there is a possibility that the payload was not properly secured.

Congressmen Support Man-Tended Station

Washington—Sen. William Proxmire (D-Wis.) and Rep. Edward Boland (D-Mass.) will continue to support NASA's space station despite growing costs, although both have indicated a strong preference for an interim man-tended design before building the more sophisticated and expensive permanently manned dual-keel configuration envisioned by NASA.

The two members of Congress, who chair NASA's appropriations subcommittees in the Senate and House, are extremely influential in directing space agency spending and policy. Both subcommittees will hold hearings during the next two weeks that will focus attention on the new station costs, which have doubled since 1984.

"My conclusion is the startling cost growth in the proposed space station should send NASA and Congress back to the drawing boards," Proxmire told AVIATION WEEK & SPACE TECHNOLOGY. "We should be seriously considering an interim step, which is a man-tended station, to gain the necessary experience in the short term that should precede any undertaking as costly and complex as a fully manned station."

Boland and Rep. Bill Green (R-N.Y.), ranking minority member of the House Appropriations subcommittee overseeing NASA, wrote the agency in late February to urge that the station be built in distinct increments, or "by the yard." This approach, they said, would let NASA achieve a man-tended capability in a shorter period and allow important milestones to be reached.

If NASA's station funding plan does not provide for early science returns by January, 1994, "it is difficult to see how this committee can support the project," Boland and Green said. A two-phased approach to the station, recently adopted by the Reagan Administration, was suggested in the letter, which said the first phase could extend through assembly flight eight or nine to provide permanently manned capability.

Benefits of adopting a man-tended platform as an interim step to a permanently manned station were discussed by Boland and William Graham, White House science adviser, at a recent hearing.

Graham said the issue of how much early capability the station should have was a "very serious question. How large the station should be depends on the benefits [it will provide]," he said. Boland said he was concerned that unless the station is built incrementally, "we may delay any benefit for three or four years" beyond the original operating date. He said his second concern was that the U.S. would spend all its money on station structure and transportation, while the Europeans and Japanese capitalized on the user benefits.

The House Appropriations Committee is expected to include language in the Fiscal 1988 NASA bill aimed at ensuring that early station assembly launch dates, which are key to providing early science returns, do not slip.

Report Identifies Early Science Work For Space Station

By Theresa M. Foley

Washington—NASA will focus on cardiovascular research, radiation experiments, crystal growth and fluid dynamics in its early space station science operations, according to a draft report that NASA soon will send to Congress.

The report identifies possible early payloads, such as a Cosmic Dust Collector, and technology experiments to gather space structures data during station assembly. The study was prepared several months ago at the request of the House Appropriations Committee, but was being held up by an Office of Management and Budget review.

NASA's space science office has developed a list of 144 possible station payloads, many based on hardware that already has flown in space or is in development. The list, like the report, has been embargoed by NASA, but several early payloads are described in the draft report. NASA officials said the draft may undergo some changes as a result of the recent White House decision to proceed with a two-phase station program (AVAST Mar. 23, p. 30).

The Cosmic Dust Collector and a Large Area Modular Array Reflector are two experiments that would be attached to the station's external structure, the draft said. They are among a number of payloads that will be considered for near-term funding in the space science and applications budget. Although full costs have not been defined, NASA believes the two would require \$10-25 million each over a three- to five-year period.

Other payloads that may be funded later include an Astronautic Telescope Facility and a 4-meter centrifuge, according to the report. The telescope would be mounted on the station's upper boom, while the centrifuge would be housed in the pressurized laboratory.

NASA's space science budget did not include specific funding for station payloads, but in response to a congressional directive the agency set aside \$14 million in Fiscal 1987 funding for early station payloads. The report said that because of the directive from Congress, the prospect for early use of the station is "greatly enhanced, if not assured." One of the greatest concerns shared by Congress and station users, both scientific and commercial, is that the U.S. will be unprepared to use the station when it finally is launched because NASA is not paying enough attention to user development now.

NASA's space technology division also has begun plans for early use of the station.

tion. It has substantially more money identified to fund early experiments. The report said \$33 million in Fiscal 1987 was earmarked for station technology work, with the expectation that the amount will grow to \$100 million annually in Fiscal 1995-96.

The Instrumented Space Station experiment will gather information on the interaction between controls and structures during the station assembly and operations phase. This experiment is expected to be comparable to early orbit flight tests that involved heavily instrumenting the space shuttle to gain technology data.

Four space technology experiments are identified for 1994, although station deployment is expected to slip to 1995-96. The experiments are categorized as Spacecraft Strain and Acoustic Sensors, Flight Dynamics Identification, Spacecraft Materials and Coating, and Cryogenic Fluid Management.

The House Appropriations Committee last year required NASA to incorporate four features into the space station plan before Congress would allow funds to be spent on hardware contracts. All of the changes contribute to the ability of the station to be used in a man-tended configuration for an extended length of time. In the draft report, NASA described its plans for implementing the four features as follows:

- A minimum of 37.5 kw. of power will be available on the station before the habitat module is launched. The first two assembly flights will carry a photovoltaic solar array system with 37.5-kw. capability, replacing the earlier plan to launch a 25-kw solar array. The second phase of the station, if funded, would increase power by 50 kw. with the addition of a solar dynamic system, resulting in total station power capability of 87.5 kw.

- A fully equipped materials processing laboratory will be launched before the habitat module.

- Payloads both external and inside the modules—will be provided early in the assembly sequence, before the launch of the habitat module. The transverse boom, which is the main structural element included in the first phase of the program, will have five payload attachment points. The upper and lower booms, now deferred to phase two, will have additional attachment points with improved fields of vision.

- Life sciences research will be provided for by the U.S., although another module may be needed to accommodate life science experiments that would interfere with materials processing work in the laboratory module. □

India Loses Science Satellite In Launch Failure

London—The first of four planned augmented satellite launch vehicles (ASLV), developed by the Indian Space Research Organization, malfunctioned last week during the scheduled launch of a stretched Rohini series (SRS) scientific satellite and fell into the Indian Ocean.

The launch attempt, from the ISRO center at Sriharikota, India (AWST May 26, 1986, p. 93), was to have placed the first 330-lb SRS satellite into a low Earth orbit. The SRS satellites have been developed by ISRO to continue scientific studies begun by the earlier Rohini series (AWST May 26, 1986, p. 97).

The ASLV is a four-stage booster using solid propellant in all four stages, plus two strap-on solid boosters to provide sufficient lift augmentation to put a 150-kg (330-lb) satellite into orbit.

Initial data indicate that the malfunction occurred in the second stage.

The SRS satellites carry gamma-ray detection equipment, a monocular electro-optical scanner system, ionospheric monitoring equipment and X-ray astronomy hardware. Each of the four planned SRS satellites will be configured for a different mission. □

NASA Will Proceed With Scaled-Back Space Station

By Theresa M. Foley

Washington—NASA will be allowed to proceed with a scaled-back, \$12.2-billion space station under an agreement for a two-phase program reached Mar. 19 with officials from the National Security Council, the Office of Science and Technology Policy and the Office of Management and Budget.

The agreement, however, provides only temporary approval to allow station contracting, which has been stalled since last August, to resume and postpones definitive White House approval until the fall. The Administration will review station costs again before hardware contracts are awarded in the fall and make decisions on the station cost, capability and annual budgets in the Fiscal 1989 budget process. NASA officials last week were awaiting approval from President Reagan and his chief of staff, Howard Baker, for the plan, which was initiated by NSC Director Frank Carlucci, OMB Director James Miller, OSTP Director William R. Graham and NASA Administrator James C. Fletcher.

The memorandum to Reagan containing details of the agreement said that "the space station is an important Administration priority for U. S. technological leader-

ship in space, international cooperation and national security. We believe that the program should not be terminated.

"We also believe that the Administration should examine more intensively lower cost alternatives for meeting your objective of achieving a permanently manned station in the mid-1990s."

NASA agreed to ask industry for methods to lower station costs.

The National Research Council of the National Academy of Sciences agreed to conduct the independent technical and cost review mandated in the memorandum. The review is due at OMB Sept. 1 for use in next year's budget formulation. It will provide "a full range of cost alternatives" to NASA's station approach, the agreement said.

The space station configuration will be reduced substantially in the early and mid-1990s as a result of the compromise. Cost estimates for the full dual-keel configuration had climbed from \$8 billion (in Fiscal 1984 dollars) to more than \$15 billion, and NASA was unable to convince the White House to approve funding for the entire program.

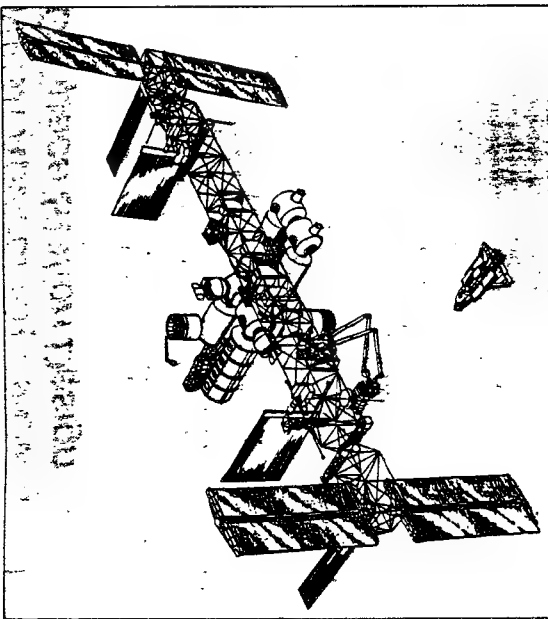
NASA will be allowed to seek approval from Congress to release requests for proposals for a phased program, the agreement said. NASA estimated the costs of the first phase at \$10.9 billion for development and \$1.3 billion for internal support. That money is expected to carry the program through Phase One, which would be complete after 10 or 11 assembly flights. The result would be a station comprising the main truss, four pressurized modules belonging to the U. S., Japan and Europe, and a solar array power system.

The polar platform also would remain in the first phase. This station would be much smaller and less capable than the full dual-keel design that NASA eventually plans.

Contributions of the international partners—pressurized modules from Europe and Japan and a mobile servicing center from Canada—would be advanced in the assembly sequence so that they are included before the breaking point between the phases.

Elements that would be deferred to Phase Two and require separate funding authority from a future Administration include the solar dynamic power system, the servicing facility, the upper and lower booms of the station and the co-orbiting platform. NASA estimated that Phase Two will require an additional \$3.4 billion.

A lifeboat for emergency crew rescue is



NASA's scaled-down space station would include a main transverse boom, four pressurized modules, solar arrays and a mobile servicing center. This configuration could be developed for \$12.2 billion in 1984 dollars, according to NASA, which recently reached a compromise with White House officials to adopt a two-phase approach to the station. The concept depicted here is the completed first phase of the station, along with a polar platform not shown.

cial said the compromise appears to favor the Marshall Space Flight Center work package. He suggested that the Texas congressional delegation may once again throw the program into a state of chaos, as it did last summer when Fletcher announced program management changes that decreased Johnson Space Center's control over the station.

Both the Lewis and Goddard centers will have large portions of their station work deferred as a result of the compromise. Although neither is expected to lay off civil servants, the buildup of contractors for support for those centers' contracts will be delayed to later in the program.

NASA's international partners were awaiting notification of the changes. Meetings with the European team are scheduled the third week of April.

Under the new station plan, NASA will launch the first station element in mid-1994, a delay of 6-9 months. Perma-

nently manned capability would be achieved in early 1996, and the station would be completed in late 1998.

Annual funding levels required for Phase One are \$1.4 billion in Fiscal 1989 and 1990, \$2.3 billion for the next three years and \$1.4 billion in Fiscal 1994. The Fiscal 1988 station request was \$767 million and NASA already has spent about \$600 million defining the station. □

not funded in the \$12.2-billion phased program, nor are the costs of transporting and assembling the station, operations or on-board experiments.

Space station contractors, who continued to express frustration over the Administration's handling of the station problems, said they expected NASA to release the requests for bids between late April and early summer, nearly a year behind the original schedule.

Station changes are expected to increase the prospect of success for the Industrial Space Facility, a commercial free-flying man-tended platform that will be built by Space Industries, Inc. The ISF could be used in place of the co-orbiting station platform, which was deferred to Phase Two, or attached to the other station modules to increase the capability of the facility, industry officials said.

Space Industries have selected Boeing Aerospace as its contractor to design the ISF docking system, which will be compatible with the space station and space shuttle.

NASA station officials said they would like to release the requests for proposals without making substantial changes. However, the requests may undergo intense scrutiny by members of Congress because of the changes. An industry off-

France Considers New Baseline For Hermes Manned Spaceplane

Paris—New baseline designs are being considered in France for Europe's Hermes manned spaceplane and its Ariane 5 launcher following a reappraisal of safety requirements in the wake of the Challenger accident.

The new Hermes design represents a major change in the spacecraft's concept. It now is equipped with an ejectable cabin sized for a crew of three instead of the larger non-ejectable cabin used in the previous design, which could have held as many as six persons.

The spaceplane's earlier payload mass target of 4,560 kg (10,000 lb.) has been reduced to 3,000 kg (6,600 lb.). Total mass of Hermes is estimated at 21 metric tons (46,300 lb.) in a circular low Earth orbit of 500 km, inclined 28.5 deg. Hermes' cargo bay with twin doors has been replaced by a pressurized cargo compartment linked to an airlock.

Weight of the two solid boosters on Hermes' Ariane 5 launcher will be increased from 190 metric tons

(418,900 lb.) to 230 tons (507,000 lb.) each, and the central core liquid stage will carry 155 tons (341,800 lb.) of propellant instead of the original 140 tons (308,600 lb.).

The British National Space Center will fund studies of Hermes as a means of participating in the program prior to a decision on full-scale development. Britain will allocate \$3.2 million to the study. Roy Gibson, BNSC director, said the British financial contribution at this stage did not indicate any commitment to the Hermes program beyond the study efforts. He said Britain's contribution would allow it to acquire data from the program and "valuable experience in advanced technologies."

Study work to be funded by Britain will include efforts at the universities of London, Swansea, Oxford and Southampton, the Cranfield Institute of Technology and several British aerospace and electronics companies, including British Aerospace, GEC Avionics and Smiths Industries.

Dial-A-Mir

The commercial Dial-A-Shuttle service offered during space shuttle missions to allow telephone callers to hear flight updates was so popular it's been adopted by the Soviet Union. Russians wanting an update on the activities of Soviet cosmonauts on board the Mir space station can now call a number in Moscow to hear the latest news from space. The number in Moscow is 215-63-56.

WASHINGTON STAFF

NASA Advisor Urges Overhaul Of Space Station Design

Washington—Scientist Peter Banks, who chairs NASA's Task Force on the Scientific Uses of Space Station, recently told the agency that its space station design was "counterproductive" to meeting urgent national science needs and recommended that the design be changed and the program overhauled to accelerate the start of on-board operations.

Banks said the current station design will not satisfy the needs of science and technology users because it will be deployed too late and be so costly that research programs may be cut to pay for it.

He recommended that the program be revised to give high priority to the quick launch of payload elements needed by the users.

Banks favors changes that would accelerate station use by deploying a simple, large module with several docking ports in about 1992 on a heavy-lift launch vehicle.

"A large, well-appointed space station that appears on the scene in 1995/96 won't be nearly as important as smaller, more flexible elements put into operation earlier," Banks said.

"It's no small wonder that we are now in trouble and that the office of space station can claim the current space station plan meets the requirements set for it: No one ever told them that in the aftermath of the Challenger accident there was a pressing need for such facilities," Banks wrote NASA. "In fact, there has been a consistent lack of office of space science and applications planning from the start, perhaps associated with the belief that space station won't happen anyway."

Banks told AVIATION WEEK & SPACE TECHNOLOGY that the members of the Task Force on the Scientific Uses of Space Station support the general premises of his statement regarding space station. The task force met in late March and approved several recommendations to be forwarded to NASA. He said the task force recognized that NASA could not undertake a major change in the station design now, but urged that an immediate, intensive study of the heavy-lift launch vehicle be started to allow new station launch options to be chosen next year. They also recognized that a simple, single module could not replace the full station facility. The task force strongly recommended more Spacelab flights and use of Space Industries, Inc.'s Industrial Space Facility to provide better access to space.

Banks' comments were not well received at NASA. NASA space station chief scientist David Black called Banks' suggestions on the space station "a series of unsubstantiated engineering schedules,

undebated laboratory concepts [and] a narrow discipline perception of the nature of attached payloads." Black said Banks' concept of a redesigned station was a 20-year-old design that is less than what the Soviets have today. "I see no reason why redesigning the space station has any merit at all," Black said. "It is what it is because of the needs of the users, and those haven't changed. So why should the station change?"

According to Banks, revising the station would ease other problems by making it easier to conclude international agreements, allowing the Defense Dept. to have its own isolated work modules and simplifying contracting by letting a single lead contractor build the large module.

Black responded that Banks was mixing technical points and "simplistic political statements" here. "We all saw how this program nearly came unglued because of silly inter-center bickering and congressional pressures," Black wrote. "The proposed scheme throws a match into a political powder keg, and you can bet that any momentum present now to have a space facility where man-assisted science can be done will vanish." □

Soviets Near Flight Test Of Small Manned Spaceplane

By Craig Covault

Colorado Springs, Colo.—The Soviet Union's small manned spaceplane vehicle, a program different from the heavy Soviet shuttle, is expected to begin full-scale manned flight testing soon.

The vehicle is expected to become the world's first space fighter, a manned vehicle providing the USSR with a quick reaction capability for space station defense, antisatellite operations, reconnaissance and emergency repair of Soviet satellites.

The Soviets have made four successful orbital flights with 1/4-scale versions of the vehicle. The new SL-16 booster that will launch the full-scale version has flown successfully several times, demonstrating launch propulsion.

U.S. Space Command officers here said that in addition to bringing the spaceplane on line operationally by about 1990, Soviet development of the heavy space shuttle is progressing more rapidly than expected. The officials said there is a high probability that first manned launch will occur by the end of 1988, with operational manned military missions being flown in the heavy shuttle by 1990.

Space Command also is assessing the Soviet Union's new SL-W heavy-lift boost-

er capability on which the shuttle will ride piggyback for manned launches.

In addition to an unmanned version using a piggyback pod capable of placing about 220,000 lb. of cargo in orbit, Space Command officers said they believe the Soviets are evaluating a straight-stack, three-stage version capable of placing 330,000 lb. in orbit—about 65 tons more than the U.S. Saturn 5 rocket could launch. This version would use six or more liquid strap-on boosters, compared with the four strap-on boosters planned for the shuttle and unmanned pod configurations.

The heavy space station the Soviets will be able to build in the mid-1990s with the shuttle and unmanned heavy lifter could eventually house 100 Soviet cosmonauts, Space Command officers said.

Launch of Soviet military cosmonauts into geostationary orbit at about 22,000-mi. altitude is possible within 15 years, officers said.

Ocean Surveillance

Space Command officers also said the quality of the Soviet military space threat is increasing as the Soviets field improved block versions of warfighting satellites such as ocean surveillance spacecraft that can target U.S. ships. At least one new type of Soviet ocean surveillance spacecraft was recently launched to a higher altitude than previous systems, increasing its survivability against the U.S. developmental antisatellite system and possibly providing surveillance benefits as well.

The Soviets are maintaining a 15% annual space expenditure growth rate and have doubled their annual space expenditures since 1980, officers here said. In addition to these Space Command assessments, the Defense Dept.'s annual Soviet Military Power report cited these Soviet space developments:

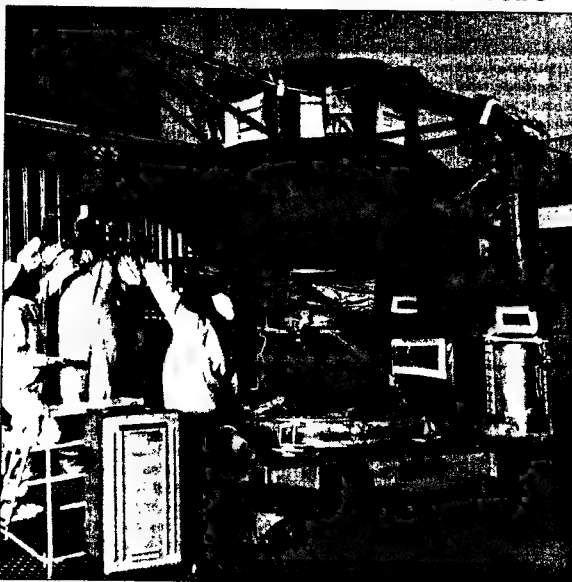
- **Soviet shuttle**—Development of the Soviet shuttle orbiter has been heavily dependent on the use of U.S. shuttle plans and technology, saving the USSR years in development.

- **Active spacecraft**—Soviet spacecraft active at any given time have increased from about 120 in 1982 to about 150 in 1986.

- **Navigation**—The Soviets acquired data on digital signal processing for their Glonass navigation system from U.S. Navstar global positioning system documents.

- **Geosynchronous planning**—The Soviets have filed their intent to launch almost 100 individual spacecraft into 25 separate geosynchronous orbit locations. □

JPL Technicians Dismantle Galileo Probe



Technicians at the Jet Propulsion Laboratory begin to tear down the Galileo spacecraft after it was returned from the Kennedy Space Center. The spacecraft is scheduled to be launched in late 1989 on the space shuttle. Use of the inertial upper stage (IUS) instead of the shuttle/Centaur upper stage will require a new gravity-assist trajectory that will take Galileo past Venus once and past Earth twice, extending flight time to Jupiter from two years to six years. The shuttle/Centaur upper stage was canceled for safety reasons following loss of the Challenger.

OUT WHERE

THERE NO

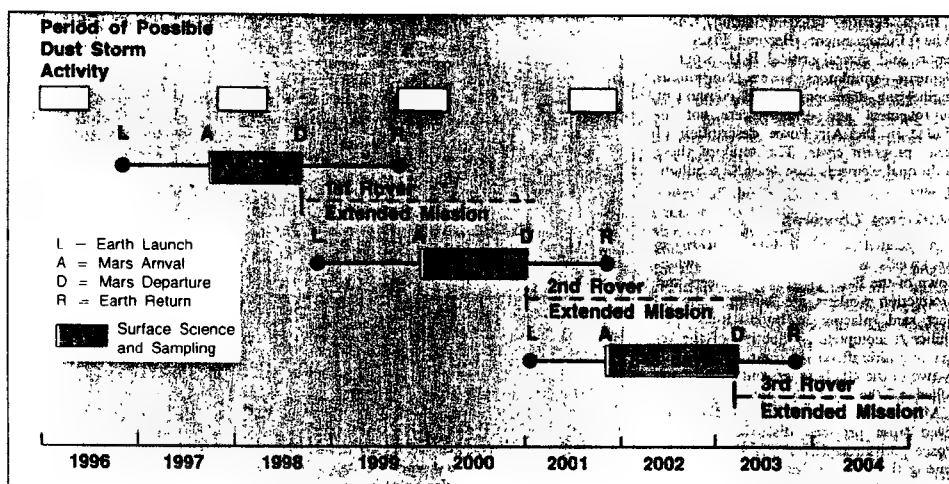
ARE

UPS

more shippings and clippings
rounded up by Greg Ruffa

DOWN

NASA Briefs Contractors on Mars Rover/Sample Return Mission



Launch opportunities for the Mars rover/sample return mission occur approximately every two years, as this chart of three possible opportunities shows. The nominal launch date is late 1998, though an

accelerated mission with priority funding may be possible in late 1996. The missions may coincide with Martian dust storms, making Mars orbit before landing desirable to wait out possible storms.

By Michael A. Dornheim

Pasadena, Calif.—NASA briefed contractors here last week on its concepts for a Mars rover/sample return mission and gave a tentative assessment of roles to be played by industry and government in the endeavor. Draft statements of work for initial study contracts were distributed.

The briefing, held at the NASA Jet Propulsion Laboratory here on Mar. 31, is a further sign of growing NASA resolve to activate its Mars plans, partly spurred on by the Soviet Union's ambitious Mars program (AW&ST Mar. 23, p. 26).

"[The Soviet program] is a very clear signal to me that it is my responsibility to make sure that the United States is in a position to do a mission with the same kind of complexity in the same time frame. So that really is the trigger on the timing," Geoffrey A. Briggs, NASA solar system exploration division director, said. JPL plans to award two \$250,000 Mars rover study contracts on Sept. 28, and NASA's Johnson Space Center plans to award two \$350,000 Mars aerocapture, entry and landing study contracts on the same date (AW&ST Mar. 16, p. 24). The contractors will produce final reports after 10 months.

Requests for proposals are due out May 1, with responses to be in by June 15.

The Mars mission will be a NASA/scientific community/industry three-part team similar to the Viking Mars lander team, Briggs said.

He gave a tentative assessment of industry participation in different parts of the project:

- Entry, descent and landing module may be a major systems contract.
- Mars sample return ascent vehicle may be a major systems contract.
- Mars orbiter and Earth return vehicles may be a major systems contract.
- Mars rover may be managed by JPL, with contractor support.
- Overall systems engineering and integration may be run by JPL with possible contractor support.

Accelerated Concept

Nominal launch date is 1998 with sample return to Earth orbit in 2001, while an accelerated Mars mission concept envisions separate 1996 launches of the rover and sample return vehicle using launchers in the Titan 4 with Centaur G-prime upper stage category.

A study item in the JPL draft statement of work is looking at both the rover and sample return in a single launch as well as in two separate launches. The single launch would require a booster more powerful than the Titan 4/Centaur G-Prime,

such as a Strategic Defense Initiative heavy-lift booster.

The preliminary NASA concept has the rover weight under 700 kg. (1,700 lb.), including 100 kg. of instruments, and the rover payload bay carrying at least 1.2 cubic meters (40 cubic ft.) of material. Numbers in the draft statement of work are not final and represent order-of-magnitude estimates for the contractors to work with, James E. Randolph, JPL rover contract technical manager, said.

The rover is to travel at least 1 km. (0.6 mi.) per day over a three-year period and be able to go up a 60% smooth grade and a 35% loose sand grade, according to the draft statement of work. The sample return vehicle could be as far as 80 km. away from the rover.

Different mission scenarios have the rover spend 0.9 to 1.5 years collecting samples before they are returned to Earth, followed by continued rover exploration.

Rover navigational accuracy without artificial external references is to be within 50 meters (160 ft.) over a 10-km. distance, and 0.5 meters to a local spot. Position accuracy with respect to absolute Mars coordinates is to be 5 km. or better, which corresponds roughly with the accuracy of Martian maps.

Contractors are to look at a range of navigation and mobility techniques that

would be available for launch from 1996 to 2000, and have backup technologies to handle development problems.

All studies assume that a Mars orbiter is part of the mission, that the Martian atmosphere will be used instead of retro-rockets to capture the vehicles into Mars orbit, that lander descent to Mars will use aerodynamic maneuvering and that the sample return will use Earth aerocapture.

Johnson landing study items include navigation system complexity versus landing accuracy, with 5-20 km. as possible limits; tradeoffs between intelligent hazard avoidance and sturdy landing gear, and relative sizing of landing retro-rockets and a parachute.

In-Orbit Assembly

Some NASA officials favor the separate launch of rover and sample return as it avoids using the heavy-lift booster class, which they see as less assured than the Titan 4. In-orbit assembly of spacecraft and upper stage was considered before the Challenger accident, but is felt implausible now.

Separate launch also may make it easier to split up the mission for international collaboration, but the present plan is an all-U.S. mission.

"We are looking at a total U.S. mission; however, we are doing it in such a manner that it would not preclude participating with the Soviets or others in a variety of modes. But we are not addressing that specific issue in the course of this study," Donald G. Rae, Mars mission study manager, said.

Unsigned Draft

The National Academy of Sciences has discussed rover collaboration with the European Science Foundation, and the mission's Science Working Group plans to add European representatives shortly. Informal contacts between U.S. and Soviet scientists have discussed the possibility of coordination, and an unsigned draft agreement between the two nations spells out significant Mars mission cooperation (AW&ST Nov. 10, 1986, p. 27).

U.S. scientists continue to face the paradox of not wishing to lose space leadership to the Soviets while needing Soviet action to rouse the U.S. program. One NASA official said the U.S. seems to be stuck moving in a cycle of ignoring, collaborating or competing with the Soviets.

JPL and Johnson Space Center will hold an industry day this week to listen to contractors' reactions to the statements of work, and a rover technology workshop is scheduled for Apr. 28-30 in Pasadena. □

Nine SDI Tests Planned in 1988-89 Amid ABM Debate Over 'Exotic' Weapons

By Paul Mann

Washington—The Strategic Defense Initiative Organization plans nine major experiments through late 1989 within the orthodox testing of the Anti-Ballistic Missile Treaty, despite the Administration's advocacy of a broad interpretation of permissible ABM testing. (AWST Mar. 16, p. 21; Mar. 2, p. 18)

Richard P. Godwin, under secretary of Defense for acquisition and the executive charged with ensuring Defense Dept. treaty compliance, outlined the planned experiments last week at a Senate Armed Services subcommittee hearing. The hearing dealt with the SDI's complex and disputed relationship with the ABM Treaty. (AWST Jan. 26, p. 22)

Godwin explained three categories of SDI testing and development that the department believes are permitted by the 1972 treaty, grouping the planned experiments accordingly. They are:

- Two "under roof" laboratory tests in Category One, conceptual design or laboratory testing. The first of these tests is designed Alpha, a ground-based laser device to demonstrate the feasibility of high-power infrared chemical lasers for space-based applications in association with Alpha, the SDIO will undertake Large Optics Demonstration Experiments (Loade) and the Large Advanced Mirror Program (Lamp). These will, respectively, demonstrate critical beam control and large lightweight space optics technologies, in a series of ground-based experiments simulating outer space. The second Category One experiment will involve hypervelocity railgun research, intended to validate the weapon potential of the gun itself, as well as associated miniature kill vehicle technology. The test will launch guided and unguided projectiles.
- Seven Category 2 experiments, in field testing of devices that are not ABM components, or prototypes of ABM components or otherwise capable of substituting for ABM components. Two of these will be performed at the White Sands, N. M., ABM test range. The first is Flare (flexible lightweight agile guided expert) to research small, nonnuclear, hit-to-kill technology for a short-range, low-altitude interceptor. The second, Skyline, involves the Mural laser, which Godwin said possesses neither the power nor the optics for atmospheric propagation at ranges useful for ABM application.

Other Category 2 tests will:

- Explore the feasibility of long wavelength infrared acquisition and tracking from an airborne platform

director of the SDIO, testified that the ERIS system could be deployed in a fixed, land-based mode on a limited basis as a "traditional" ABM interceptor technology known in 1972.

Abrahamson acknowledged that there are many similarities between ERIS technology and that of another early ABM deployment candidate, space-based kinetic kill vehicles (KKVs). These statements immediately gave way to questions about whether either technology could be tested legally under any interpretation of the ABM Treaty.

Sen. Sam Nunn (D-Ga.), chairman of the Armed Services Committee and the Senate's most authoritative advocate of a narrow, orthodox interpretation of the treaty, took Abrahamson's statements to mean that as traditional technologies, neither ERIS nor KKVs would be technologies based on "other physical principles"—a key phrase in the treaty referring to "exotic" technologies that became known after the treaty's signing in 1972.

Technologies based on other physical principles are a crucial part of the Administration's broad interpretation, which holds that testing of such technologies is legal. But Article 5 of the treaty expressly prohibits the development, testing or deployment of ABM systems or components "which are sea-based, air-based, space-based or mobile land-based."

The significance of Abrahamson's statements, Nunn said, is that if both ERIS and KKVs are traditional technologies, not "other physical principles," then "even if the broad interpretation applies, which permits testing of other physical principles, then this particular system [KKV], now being looked on for possible early deployment, could not be tested under the broad interpretation, any more than it could be tested under the traditional interpretation."

"That means... this whole exercise we're going through in terms of broad versus traditional interpretation in all likelihood has no bearing on the question of testing the system which has been slated for early deployment."

Godwin said his office had not decided whether kinetic kill vehicles are based on other physical principles. He said he would need several weeks to render a judgment on the nature of the technology, once senior Administration policymakers settle on a definition of the phrase, now under study. He said the question of other physical principles would not be relevant to the nine SDI experiments planned for 1988-89. □

Washington—The Strategic Defense Initiative Organization is assessing a novel energy storage system using superconducting technology that could power ground-based free-electron lasers for ballistic missile defense, as well as helping to meet peak power demands of electric utilities.

The system, based on a concept invented in 1970 by scientists at the University of Wisconsin, is called superconducting magnetic energy storage (SMES).

A ground-based free-electron laser facility for SDI application would require instant access to a source capable of delivering approximately 1 gigawatt (1,000 megawatts) of power. (AWST Aug. 18, 1986, p. 40)

A dedicated facility capable of delivering such power levels that would be used only in event of missile attack would be extremely expensive and not cost-effective, according to C. Paul Robinson, senior vice president of Ebasco Services, Inc. Robinson recently briefed SDIO officials on the proposed SMES.

The system could be used in peacetime to supply early morning peak-power needs of public utilities, which are much lower than SDI needs, while still being available to provide the energy needed for free-electron lasers.

A group calling itself the Wisconsin Team, which includes the University of Wisconsin at Madison, the Madison Gas & Electric Co. and Ebasco, is seeking SDI Organization funding to build an operational prototype capable of delivering 20 megawatts (72 gigajoules). The facility could be completed in five years at a cost of \$60 million, according to Robinson.

This prototype facility would contain a 300-ft-dia. coil of niobium-titanium wire, submerged in liquid helium within a vacuum vessel, Robinson said.

Electric power fed into the SMES would circulate continuously in the giant coil until needed to supply public utility high-peak power loads, and would then be recharged later in the day when power demand drops.

For SDI application, the power could be delivered in a fraction of a second to meet the pulsed-power needs of a free-electron laser. The proposed 20-megawatt prototype could deliver 1 gigawatt for approximately 36 sec., according to projections.

Using available superconductor materials, SMES could operate with an overall efficiency of about 95%, Robinson said. An even higher 98% efficiency could become available with new superconductor materials recently developed in Japan, he added. □

SDIO Assesses Energy Storage For FEL Defense

Reagan Asked to Intercede To Save Landsat Program

By Theresa M. Foley

Washington—Top U.S. defense and intelligence officials have requested a meeting with President Reagan to discuss their concerns that the Landsat remote sensing program will be ended soon, a senior Defense Dept. official testified before Congress last week.

Donald Latham, assistant secretary of Defense for command, control, communications and intelligence, said Defense Secretary Caspar W. Weinberger and acting Central Intelligence Agency Director Robert Gates have asked Reagan for a cabinet-level meeting on Landsat. Gates recently wrote National Security Council Director Frank Carlucci to call attention to Landsat problems, Latham said.

National Security

"The Landsat system will surely increase its contribution to our national security—but only if it survives the series of difficulties caused by the process of commercialization," Latham said. He presented the subcommittee with two versions of his testimony—open and classified—explaining the importance of Landsat to the Defense Dept. (AWST Mar. 23, p. 62)

Latham was very supportive of continuing Landsat, but stopped short of endorsing a two-satellite system, calling only for the launch and operation of Landsat 6. Unless Reagan intercedes, the fate of Landsat will be left in the hands of the Office of Management and Budget, which has a long history of opposition to continuing federal investment in the program.

OMB is considering a revised Landsat proposal that was received after the last OMB-approved plan, for a one-satellite system, was rejected by the Senate (AWST Feb. 9, p. 17). The Commerce Dept., which has responsibility for the Landsat program, wrote OMB Mar. 4 that only two Landsat options remain, approval of a two-satellite plan or termination of the program.

OMB policy has been that the private sector role in financing Landsat should be greater and that the federal government should not fund both follow-on satellites, even though that was part of the original agreement with Eosat. Congress, which supports the continuation of Landsat, is insisting on adherence to the two-satellite program mandated in the original contract.

A Landsat hearing before two House subcommittees last week, aimed at shedding some light on Landsat's future, left a "fog of confusion" around the future of the program, subcommittee members said. OMB Deputy Director Joseph R. Wright said the Administration continues to support Landsat commercialization, but that its benefits do not justify increased federal investment in the technology. "If Congress were to decide not to continue Landsat, I question whether the impact on the users would be significant," Wright said. The Landsat archives contain nearly one million scenes and films, and additional "data will still be available from U.S. allies' satellites," he said.

Defense Dept. has not been willing to financially support Landsat, and other users have not stated strongly enough that

NASA Will Compete New Shuttle Booster

payment for phasing SRB production down, if it lost.

The advanced motor will use new automated manufacturing methods to improve quality and safety and could increase shuttle payload performance.

Five companies that studied alternative solid rocket motor concepts last year under contract to NASA and possibly other qualified firms will be allowed to compete for definition. (AWST Feb. 9, p. 116). NASA has \$15 million for the definition work, which could start by July. NASA laid out engineering definition work on the new solid rocket motor would be done in Fiscal 1987-88, and a decision to proceed with a production contract, worth an estimated \$2.4 billion, could be made as a Fiscal 1988 start.

Washington—National Aeronautics and Space Administration will proceed with competitive definition of an advanced solid rocket motor for the space shuttle that could be put into use by Fiscal 1993.

Conceptual studies of alternative liquid-booster technology will be undertaken simultaneously, NASA said.

After much pressure from Congress, NASA decided to compete a procurement to define the new solid motor, but not to introduce competition earlier for the redesigned rocket boosters. The decision could break Morton Thiokol's monopoly of shuttle solid rocket booster work if the company does not win the advanced motor for competition. Thiokol will earn more than \$2 billion under its current SRB contract and would receive a substantial

NASA Seeks Major Role In Developing Heavy Launcher

By Theresa M. Foley

Washington—NASA has asked the Air Force for a major role in developing the heavy-lift launch vehicle and has produced a preliminary internal analysis of how the space station could be changed for launch on the HLLV in the early 1990s.

The space station HLLV use study, headed by Langley Research Center official W. Ray Hook, was presented to NASA Deputy Administrator Dale D. Myers in early 1987. NASA space station officials deny that any redesign work is being done to allow a switch from the shuttle deployment plan to one relying on the HLLV, but the Hook study presents several options for station design changes to take advantage of the more powerful launcher.

Design Options

The options identified by Hook include modifying the station's transverse boom to make it collapsible for launch, along with several other early station elements, on one HLLV. Another option focuses on launching the pressurized modules—either separate habitat/laboratory modules and their nodes or a combined, large habitat/laboratory module—on an HLLV. The Hook study said the transverse boom could be redesigned during the upcoming

form. While the shuttle may not be available from the West Coast, Titan 4s are considered to be too expensive for the program. The new satellites will cost \$296.8 million, nearly \$50 million more than the original contract, and be launched about 18 months later than first planned.

Clarence Brown, deputy secretary of the Commerce Dept., cited four factors that have affected Landsat commercialization this year:

- The unwillingness of the private sector users and Eosat to share in financing the program.
- Increasing budget deficit reduction pressures.
- Increasing costs associated with reduced shuttle launch capability following last year's accident.
- Competition with the French and Japanese.

Rep. George Brown (D-Calif.) said he fears that the U.S. will be bypassed very quickly by the Japanese, French or a multinational consortium in remote sensing. Other nations can be expected to launch satellites with 1-meter resolution or real-time data flow. "We're going to be dead in the water," he said.

During the hearing, questions were raised on whether the Eosat concept was the best possible in the face of increased international competition. "We may be in a position where we have to negotiate or re-compete under procurement law because we're seeing technology change and the competition move faster," Commerce's Brown said. "Maybe we aren't in the game" with the Eosat plan, he said. [1]

the data are needed, he said, citing some of the reasons against continuing Landsat. Demand for Landsat products has not developed, he said. According to Wright, the Commerce Dept. has submitted "confusing" proposals that have too many technical changes and appeared likely to result in cost overruns.

Wright said he hopes the private sector will step forward and fund a Landsat system. OMB came under attack during the hearing for backing away from its \$250 million commitment to Eosat, the company that was selected by the Commerce Dept. to privatize the Landsat system.

Data Continuity

Rep. James Scheuer (D-N.Y.), chairman of the House subcommittee on natural resources, agriculture research and the environment, said the congressional consensus is that a two-satellite system is "an indispensable necessity to preserve continuity of data flow."

Eosat's proposed Landsat follow-on system has changed technically several times since the contract was awarded. Eosat submitted a new proposal and additional costs in February. Commerce Dept. officials testified that the contract may have to be re-competed as a result.

The latest Eosat proposal called for two satellites based on the Tiros weather satellite bus, a switch from the current contract that includes use of the large, serviceable Omnistar spacecraft. The satellites would be launched on Titan 2 launch vehicles, not the space shuttle. A West Coast shuttle or Titan 4 launch would have been required for the Omnistar platform.

launch vehicles and propulsion systems, to be a strong participant in defining and implementing an early HLLV and longer-range capabilities," Myers wrote.

NASA and the Air Force are close to an agreement under which the space agency would be given major technical responsibilities for the HLLV program, while the Air Force would retain nearly all of the management and operational responsibility for the vehicle, according to industry officials. The Air Force also is expected to pay most of the HLLV development costs.

Marshall Organization

NASA has established an HLLV organization at Marshall Space Flight Center, which may be given major engineering work on the HLLV for systems such as propulsion and guidance. In his letter to Air Force Secretary Edward C. Aldridge, Force HLLV plan is inadequate to prepare for full-scale development.

Myers asked that several NASA/industry studies being managed out of Marshall be continued and accelerated in association with the HLLV. The studies are:

- Advanced Space Transportation Booster Engine (liquid oxygen/hydrogen).
- Advanced Space Transportation Main Engine (liquid oxygen/liquid hydrogen).

continuing the trend toward very large, expensive missions such as the Hubble Space Telescope. "The accident has dramatized the risks of a space science program that is dominated by large projects," CBO said, citing the telescope, which cost \$1 billion and requires an estimated \$200 million annually to operate.

The CBO baseline budget for NASA rises from \$8.9 billion in Fiscal 1988 to \$10.5 billion in Fiscal 1992. The report presents three alternatives—space transportation, space station and space science—as options for funding increases that will allow Congress to give specific areas of NASA's budget higher priority.

The report provides substantial evidence that NASA's ambitious plans and available federal resources for civilian space efforts remain widely divergent. Possible new NASA initiatives that are not addressed in the budget analysis, but that require substantial funds in the next few years, are the heavy-lift launcher and the heavy-lift launch vehicle.

NASA Budget Needs Exceed CBO Spending Levels by \$14 Billion

The mixed fleet that NASA needs, but has not yet started, will cost \$700 million to \$2.3 billion over five years, depending on how many expendable launch vehicles are purchased, according to the CBO.

The space station program commitment is expected to cost as much as \$30 billion in 1988-2000. While the Challenger accident has strengthened the case for the station by "creating a perception that U.S. leadership in space is being lost," it also has added to the case against the station by "calling attention to the uncertainty of its benefits and its final cost," the CBO said.

The usefulness of the station is being questioned, as is the ability of the space shuttle to support station construction, the report said. Station construction also may require two-thirds of the shuttle mission for several years, deferring other crucial military and science payloads.

Another key issue is whether to direct more space science funding to intermediate and small-scale projects, instead of

■ Propulsion Avionics Module Recovery

NASA has asked that the HLLV program announcement be amended to place greater emphasis on the space station's potential requirement for the vehicle. Other proposed changes would reduce the Air Force emphasis on specific cost decreases for space transportation in favor of NASA's preferred emphasis on launcher reliability.

While the Air Force and Strategic Defense Initiative are most concerned with reducing space transportation costs by a factor of 10, NASA is more concerned with achieving a highly reliable vehicle because it cannot afford to lose payloads due to launch failures.

Myers asked that the program announcement include a first launch of the early HLLV configuration in 1992 and initial operating capability in 1993. Station deployment is planned to begin in 1994.

In the Hook study, NASA considered HLLV versions with one, two or three shuttle main engines. The single-engine version would allow fully outfitted pressurized modules to be launched, something that the shuttle cannot accomplish with current weight constraints. The dual-engine HLLV would be able to launch the modified transverse boom in a single flight. The three-engine version, with 150,000-190,000-lb. payload capability, would provide desired performance levels even with one engine out [1]

STRATEGIC DEFENSE INITIATIVE

SDI Director Denies Covert Shift Of ABM Research to Deployment

By Paul Mann

Washington—The Strategic Defense Initiative is being reoriented "covertly" from antiballistic missile research to accelerated deployment, without a presidential directive or congressional approval, without a cost estimate and without a plan for phase-two deployment, according to a partisan Senate report.

Commissioned by two SDI critics on a Senate defense subcommittee, Democratic Sens. J. Bennett Johnston (La.) and William Proxmire (Wis.), the report alleged that the Strategic Defense Initiative Organization has established a secret black program to develop a reference architecture blueprint for ABM defenses in the mid-1990s. The report acknowledged that SDIO had denied the allegation in connection with the report's classification review, prior to release.

In a subsequent letter of rebuttal to Johnston and Proxmire, SDI director USAF Lt. Gen. James A. Abrahamson said no decision had been made to pursue near-term technologies or restructure research for early deployment. He said his program continues to address "the spectrum of mature and advanced technology research," placing emphasis "where I consider it critical, such as the shortfall in space transportation."

The Senate report, written by staff members James T. Bruce (for Johnston) and Douglas C. Waller (for Proxmire) and issued last week, was based on interviews with more than 60 SDI and government laboratory scientists, engineers, project managers, industry officials and antimissile experts. It said the alleged black architecture, program resembles a limited version of the three-layer antimissile defense proposed late last year by the George C. Marshall Institute, a pro-SDI public policy group here (AWAST Jan. 26, p. 22).

Kill-Vehicle Programs

As further evidence of SDI's reorientation, the report cited an order last December by Abrahamson directing that research into space-based kinetic kill vehicles (SBKs), a prime near-term deployment candidate, be altered in nature and split into two programs. Instead of pursuing a robust, 95%-effective defense with the high-speed antimissile projectiles, Abrahamson ordered that \$75 million in Fiscal 1987 funding be split, with \$70 million designated for a partial near-term option and just \$5 million for a later, comprehensive defense. SDIO's five-page rebuttal did not address this matter.

The black architecture is compartmentalized so that only a few members of Congress would be allowed to review it if they knew of its existence, according to the report. It said knowledge of the program also has been withheld from many SDI scientists and "it appears that key parts of the Administration—particularly in the State Dept. and the Arms Control and Disarmament Agency—have been kept in the dark," as well.

External Forces

Whether the secret architecture exists or not, external forces, including Congress and the Marshall Institute plan, have helped to push SDI research in the direction of near-term possibilities. An independent SDI analyst for the Library of Congress, Cosmo DiMaggio, pointed out that when Congress adopted the Fiscal 1987 National Defense Authorization Act last year, it mandated more attention to ABM defense in the near term, while complaining of inattention to architecture. The act ordered the Defense Dept. to prepare a detailed report, now pending, on ABM technologies that could be developed or deployed within the next 5-10 years and identified specific SDI program elements pertinent to such applications.

The act also stated that SDI spending, DiMaggio said that faced with the legal

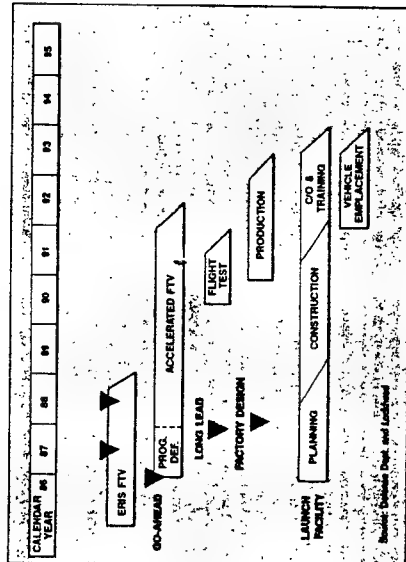
now at \$3.5 billion, was excessive without a basic architecture. It declared that "a portion of the SDI research program should emphasize options for near-term deployment as a hedge against the possibility of a Soviet ABM 'breakout' in the near term." SDIO is paying inadequate attention to such issues.

DiMaggio said this legal language, along with the Marshall Institute proposal and pressure for movement from Defense Secretary Caspar W. Weinberger, helped induce a pendulum swing. When Congress directed SDIO to retreat somewhat from advanced research in favor of near-term technology, he said, Abrahamson went beyond what a majority of Congress had in mind, but certainly not to the exclusion of long-term research. Bruce and Waller made a similar point.

They deduced from their review of SDI research and contractor assignments that a partial ABM system would be 16% effective against incoming Soviet warheads, comprising token deployment of space-based kinetic kill vehicles and 400-1,000 ground-based kinetic interceptors.

The Marshall Institute envisioned a three-layer defense with boost, midcourse and terminal phases, consisting entirely of thousands of thousands of kinetic kill vehicles both space- and ground-based.

DiMaggio said that faced with the legal



Defense Dept. Official Cites Need For Early Decision on Space-Based Radars As Part of ADI Surveillance Network

Washington—A decision on whether to include space-based radars in the overall concept for the Pentagon's planned Air Defense Initiative will have to be made next year before determining whether to deploy such a system in the early 1990s, according to a senior Defense Dept. official.

Lawrence W. Woodruff, deputy under secretary of Defense for strategic and nuclear forces, said the Defense Dept. wants to begin designing a comprehensive system architecture for ADI by 1990. A determination on whether to include a space-based radar in the system would have to be made by 1988 to allow enough lead time to complete the necessary research and system concept studies, Woodruff told a gathering of industry officials at an Electronic Industries Assn. conference here last week.

The ADI concept involves the development of a layered network of surveillance, tracking and engagement systems to counter the threat posed to the continental U.S. by strategic bombers and air- and sea-launched cruise missiles (AWAST Feb. 2, p. 18).

The feasibility of employing space-based radars to detect and track bombers and cruise missiles is being examined for the very long-range portion of an ADI surveillance network. Woodruff said there is a "compelling need" for an ADI program given the increase in quality and numbers of Soviet bombers and submarines carrying cruise missiles. He cited the new Blackjack bomber, which will soon be fielded by the Soviets, the continuing deployment of the new AS-15 long-range cruise missile on Bear H bombers, and the anticipated deployment of new SS-NX-21 and SS-NX-24 cruise missiles on Soviet submarines as early as next year.

Initial Assessment

An initial assessment of the operational requirements for an ADI system is expected to be completed in the very near future, Woodruff said. The Joint Chiefs of Staff have directed the U.S. Space Command and the North American Aerospace Defense Command to provide the assessment. The entire project is being coordinated by an interagency steering committee comprising representatives from the three services, the joint chiefs, the Strategic Defense Initiative Organization and the Defense Advanced Research Projects Agency. The Air Force is the lead agency in terms of project coordination for the steering committee, which is overseen by Woodruff's office.

Woodruff said there is a "compelling need" for an ADI program given the increase in quality and numbers of Soviet bombers and submarines carrying cruise missiles. He cited the new Blackjack bomber, which will soon be fielded by the Soviets, the continuing deployment of the new AS-15 long-range cruise missile on Bear H bombers, and the anticipated deployment of new SS-NX-21 and SS-NX-24 cruise missiles on Soviet submarines as early as next year.

Countering Soviet air-breathing threats will become even more difficult in the 1990s, Woodruff said, as the Soviets continue to improve their advanced penetration technologies, including low-observable technology. He also cited the threat posed by a new generation of very quiet, Soviet cruise missile-carrying submarines that would be able to operate in the cluttered environment close in to the coast, thereby greatly reducing the amount of warning time in the event of a launch.

ADI officials are examining a multi-tiered system of surveillance technologies, sensors and weapons systems capable of locating, tracking and engaging air-breathing threats to the continental U.S. at short ranges, long ranges and very long

mandates of last year for more focus on the near term, "if I had been Abe [Abrahamson] I would've said, 'What Congress needs is an architecture they can see and the only one I can give them [in the] near term is, of course, going to be similar to Marshall because [the kinetic kill technologies are] the most mature and they also meet the need for a multilayer defense.'"

Part of an early deployment in compliance with the 1972 Antiballistic Missile Treaty would involve 100 ground-based prototype kinetic kill vehicles in the form of Lockheed's Exoatmospheric Reentry Vehicle Interceptor System (ERIS), a late midcourse interception missile. ERIS could be installed at the abandoned Safeguard ABM site at Grand Forks, N.D.

Bruce and Waller reported that Lockheed engineers have surveyed the site and that company officials estimate the cost of a 10-year, 100-missile deployment at \$3.5 billion.

But Abrahamson ruled out this option. He told AVIATION WEEK & SPACE TECHNOLOGY that deploying ERIS in this way would not provide the comprehensive military capability desired from ABM defenses. ERIS was a feature of the much broader Marshall Institute plan, which drew on briefings from Abrahamson's office and the Defense Intelligence Agency. □

Senate Queries Rushed HLLV Schedule

Washington—A purported shift of Strategic Defense Initiative research to near-term options includes rushed development of the heavy-lift launch vehicle (HLLV), which would be built in two versions, according to a Democratic Senate staff report.

The Strategic Defense Initiative Organization denied pursuing an accelerated HLLV schedule, saying planned concept definition efforts are a logical successor to combined Air Force, NASA and SDIO space transport studies designed to address emerging launch shortages.

The Senate report said SDI officials have directed engineers to take the design envisioned for turn-of-the-century heavy-lift "and work backward to determine what could be done for" the near term. Instead of lifting material into space for \$200-400 per lb. by the year 2000, SDI and the Air Force Systems Command now are seeking a launch cost of \$1,000 per lb. by 1992-93, the report said. Current costs are \$1,500-3,000 per lb. The report said evidence of the urgency

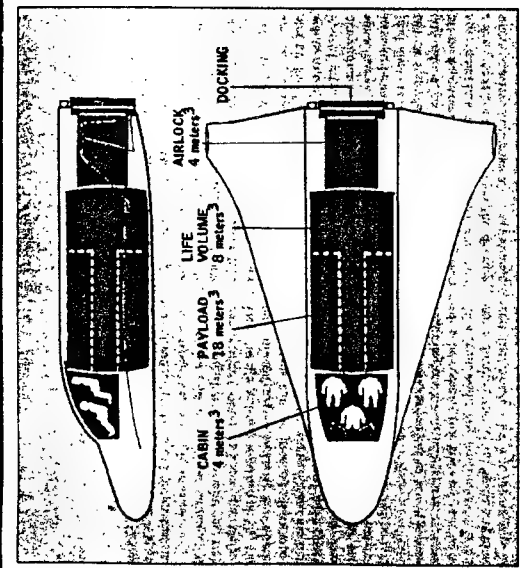
of the Air Force has attached to producing an interim HLLV could be seen in a draft Program Research and Development Announcement (PRDA), a document that solicits design study proposals from contractors. "Under this draft PRDA the contractors would have only 30 days from the date of the PRDA's publication to respond with a design study proposal for the HLLV," the report said.

As reported in AVIATION WEEK & SPACE TECHNOLOGY, both the Air Force and NASA have written draft PRDAs and a third and probably final version has been developed by SDIO (Apr. 6, p. 25).

The Senate report likened the two-phase undertaking to transforming, in half the normal time, a standard American 20 mpg. sedan into a vehicle that carries three times more weight with fuel economy of 60 mpg. In the mid-1990s, the HLLV is projected to haul 100,000-150,000 lb. per launch, but that would not meet the near-term ABM requirement, the report said.

Electable Crew Cabin, Pressurized Cargo Bay Proposed for Hermes

New baseline design under consideration for Europe's Hermes manned spaceplane would have an ejectable crew cabin and a pressurized cargo compartment. The closed cargo compartment replaces the twin-door payload bay incorporated in previous Hermes designs, while the crew cabin's size has been reduced from the earlier concept to allow for the cabin's separation and recovery in case of a launch accident. A docking port is at the rear of the spaceplane, replacing the orbital insertion motor previously located there. The motor could be eliminated from Hermes if the Ariane 5 that launches it is configured to inject the spaceplane into low Earth orbit. Total launch mass for Hermes has grown to 21 metric tons (46,300 lb) from the previous mass of 18 tons (39,700 lb). The Hermes concept was conceived by France to perform a range of in-orbit resupply, repair and research duties.



der being divided between various technologies such as noncooperative data fusion and advanced data processing. Woodruff said the most difficult portion of the battlefield management portion of ADI will be to develop a survivable and reconstitutable C' system.

Funding for engagement systems is about evenly split between research on a hypervelocity, long-range ground-to-air missile and advanced fire control systems. ADI officials also will be evaluating other weapon systems being developed by the individual services for possible ADI employment.

Phased-Array Radars

The system would involve large-aperture phased-array radars carried on an airborne platform. The Air Force is considering employing a fixed-wing aircraft far advanced over the current fleet of Boeing E-3 Airborne Warning and Control System (AWACS) aircraft. But Woodruff said the possibility of employing airships in the role is also being studied as a less expensive way to provide constant surveillance.

Active and passive acoustics research accounts for about two-thirds of the funds earmarked for undersea surveillance, with the remainder being divided between non-acoustic sensor technologies and an overall evaluation of antisubmarine warfare systems to counter advanced cruise missile-carrying submarines.

About one-third of the battlefield management C' funds will go toward overall system concept studies, with the remain-

ranges, Woodruff said. The short-range tier would include local and wide-area surveillance and terminal defenses while the long-range tier would locate, track and engage air- and sea-launched threats as far as 700 km. off the coast of the U.S. The ultra-long tier, which would involve space-based radars and hypersonic missiles, would deal with threats as far as several thousand kilometers off the coast. Woodruff said a space-based radar would allow the tracking of low-flying cruise missiles throughout their trajectory as well as determining their point of origin.

Funding levels for ADI have risen dramatically this year. The Defense Dept. is asking for \$173 million in ADI funding for Fiscal 1988, an increase of more than \$140 million over Fiscal 1987. Another \$280 million is being sought for Fiscal 1989.

More than a dozen research contracts, mainly in the area of surveillance technologies and overall systems concepts, have already been awarded by the Air Force's Electronics Systems Div. In addition, ADI will draw on current research and development in associated air defense projects that could be applied to ADI. ADI's budget is broken down into four main areas:

- **Air surveillance**—\$94.4 million in Fiscal 1988 and \$140.5 million in Fiscal 1989.
- **Undersea surveillance and antisubmarine warfare**—\$47.2 million in Fiscal 1988 and \$67.4 million in Fiscal 1989.

28 AMATION WEEK 4 SPACE TECHNOLOGY/April 13, 1987

By Theresa M. Foley

NASA would like to award the contracts around Oct. 15, NASA officials told a House panel. A systems engineering support contract will be selected in July. NASA received two bids Apr. 3 for the \$1-billion-plus contract. Lockheed, TRW and Planning Research Corp. have teamed to compete with Grumman and Ford Aerospace for the work.

Power Adequacy

Space station users are alarmed over one aspect of the new station plan—the reduction in power from 87.5 kw to 50 kw. for Phase One. NASA has deferred the solar dynamic power system to the second phase and plans to provide only photovoltaic power in the first phase. Station housekeeping requires 10 of the 50 kw, which means that only 20 kw will be left for users. Microgravity scientists require more power for their experiments to get maximum use out of the station, according to a German space official.

"The station will be able to do an appreciable amount of materials processing," Andrew J. Stefan, NASA associate administrator for space station, said. "The final amount of power will be adequate." He said the power situation is being reviewed again to address these concerns and that additional changes could be made to the power package, which is managed by the Lewis Research Center. NASA was being pressured last week by members of the Ohio congressional delegation to minimize the effect of the revised station plan on Lewis and its contractors.

NASA was able to release to congressional appropriations committees on Apr. 6 a station implementation plan that had been put on hold by the Office of Management and Budget. Congressional approval of the plan is required before hardware requests for proposals can be issued.

NASA and the Office of Management and Budget are discussing a firm cost ceiling for the Phase One station program and a three-year budget authorization for the program.

An additional hardware element will be contributed by the European Space Agency as the result of a recent NASA policy reversal regarding the addition of a European detachable man-tended module to the station.

Last year, NASA told the Europeans that they would not be allowed to fly the module with the station because it would be too complicated and expensive to plan for repeated docking and undocking. But NASA recently informed the Europeans that it has decided the detachable module will be permitted. The Europeans are not expected to deploy the module until the late 1990s because it is planned for launch on Ariane 5, which will not be available until 1995 or later.

Total cost of the first phase of NASA's station could reach \$20 billion in 1988 dollars by 1996, if such expenses as transportation, a lifeboat, ground facilities, operations and other incidents not included in NASA's estimate are added. Nelson asked NASA officials to translate the station costs from 1984 dollars, which NASA uses to 1988 dollars. They provided the following breakdown (all in 1988 dollars):

- Hardware and NASA laboratory development will require \$14.3 billion, which equates to the \$12 billion (1984 dollars) approved by Reagan.
- Transportation, which includes mar-

Soviets Dock Module to Mir Following Aborted Attempt

Soviet cosmonauts Yuri Romanenko (left) and Alexander Laveikin are shown on board the Mir space station following the aborted docking attempt Apr. 5 with the Kvant astrophysics module, which carries Soviet and European X-ray astronomy instruments (awest Apr. 6, p. 24). On Apr. 9, on the second attempt the Soviets successfully docked the modules at 00:36 GMT. But problems remained in completing the electrical connection between the facilities, according to Geoffrey Perry of the Kentering Group, which monitored both events. Perry said the cosmonauts were in good spirits following the successful docking, indicating that the electrical problem may not be serious. The Soviets attributed the docking difficulty to a problem in the Kvant's control system and said that parameters used in training for the docking may have been too strict.



AMATION WEEK 4 SPACE TECHNOLOGY/April 13, 1987 27

New Assessment Slips Shuttle Launch to September, 1988

final costs of 16 shuttle missions, is \$1.2 billion.

- Facilities will cost \$239 million
- Transition definition money, which will be used "to see how the station could grow or change," is set at \$200 million.

Flight teleonomic system will cost \$288 million.

- Operations through 1996 will cost \$3.25 billion.

NASA officials protested when Nelson added these amounts to reach \$20 billion. NASA Deputy Administrator Dale Myers said it was unfair because other programs, such as space science, do not have to add transportation costs into their estimates. He also objected to adding \$1.5 billion for NASA laboratory development into the station total.

Expendable Launchers

NASA is keeping its options open for a switch from launching the entire station on the space shuttle to boxing part of it on expendable launchers. NASA Administrator James C. Fletcher last week told the House Appropriations subcommittee on independent agencies that NASA "would like to assemble part of the station or at least resupply it with ELVs. The problem is the choice of ELVs is limited." However, a shuttle-derived vehicle, if developed, could be accommodated within the current station contracts, he said.

Rep. Edward Boland (D-Mass.) chairman of the House Appropriations subcommittee on NASA, expressed strong interest in advancing the first station element launch to Jan. 1, 1994. NASA originally wanted to begin launching station parts in 1993, but has slipped that date several times. Boland is a vocal advocate of achieving early science returns from the station, and asked NASA how much money would be required to stick with the January, 1994, deployment start. Stofan said OMB has restricted NASA to \$1.5 billion for the station in Fiscal 1989 and 1990, and that NASA would need an additional \$250 million and \$420 million, in each respective year, to keep station deployment on the earlier schedule.

Space Science

NASA also was asked about recent suggestions by scientist Peter Banks, who was chairman of the NASA Task Force on the Scientific Uses of Space Station, to accelerate the space station program to 1992-93 by changing the design and launching on a Heavy Lift Vehicle (aVAST Mar. 30, p. 28).

Stofan said that Banks has resigned his chairmanship of the advisory committee and that "the experts in microgravity science and life science don't support his position." The Banks proposal would only make the budget situation worse, Stofan said, because it would require more early funding for the HLV. □

Kennedy Space Center—Next space shuttle launch cannot be attempted before September, 1988, if current processing and hardware preparation procedures continue and if, as expected, a wet countdown demonstration test and a flight readiness firing precede the resumption of shuttle operations.

This flight date is the forecast of a Kennedy Space Center government and contractor management assessment as of April 4 following an analysis of major items that will affect the launch of Mission 26, the designation of the next shuttle flight.

NASA has been aiming toward a February, 1988, launch date. The most recent assessment does not take into account activities under way at Johnson Space Center and Marshall Space Flight Center or by their contractors that could add to the delay.

Neither does it add any time to retest any Criticality 1 items that could be damaged or worn in a live firing.

The Kennedy launch date estimate is based on three factors:

- The procedures being established for orbiter processing will be 11 weeks late because of the failure modes and effects analysis/critical items list updating under way as the result of the Challenger accident.

NASA May Need \$350-Million Fund Boost To Restore Shuttle to Safe Flight Status

(DSCS) spacecraft can be flown on the shuttle without significantly degrading the satellites' lifetimes.

Rear Adm. Richard H. Truly, NASA associate administrator for space flight, told the House Appropriations subcommittee on independent agencies April 7 that the DSP and DSCS missions could stay on the shuttle if some propellant were offloaded, but that the launch altitude and mission duration would be reduced. An Air Force official said the satellites will use Titan 4s instead.

The Air Force is bailing its future launch schedule on the assumption that shuttle flights would resume in June or July, 1988, even though NASA maintains that the February date for resumption of flights can be achieved, according to Rep. Edward Boland (D-Mass.), subcommittee chairman. Truly conceded that the chances of making the February date were "getting slimmer and slimmer." He said NASA has begun to assess threats to the date, which include personnel and documentation, and proposed new content to the recovery program, such as the engine flight readiness firing.

In addition, the shuttle's new projected payload capability is too low to launch two key Air Force satellite series while the satellites are fully fueled, NASA officials confirmed. Neither Defense Support Program (DSP) early warning nor Defense Satellite Communications System

A flight readiness firing would be scheduled about two months before launch. If any serious problems developed during this test, NASA management would be faced with a decision on how deeply it would probe into such Criticality 1 items as the main engines or auxiliary power units.

Modification of the orbiter for a crew escape hatch represents a one-month rollout delay from the processing facility. A decision on the hatch is scheduled in June. It has not been decided if the modifications would be done here at Kennedy or at the Rockwell plant in Downey.

Another delay concern is wet problems in the space shuttle main engine. If current eddy inspection techniques at Rockwell are not successful, engine deliveries could be delayed as much as 10 weeks. Results of the eddy tests are expected late this month.

Kennedy has identified a number of concerns for shuttle flights beyond Mission 26. They include late delivery of solid motors, two months for Mission 27 and 10 weeks for Mission 28; eddy test results at Rockwell; which affect engines for all missions; funding to activate the third mobile launch platform; and several unresolved software issues. □

McDonnell Douglas Astronautics Receives Nine \$50,000 Deposits For Commercial Satellite Launches

Washington—McDonnell Douglas Astronautics Co. has received nine \$50,000 deposits to reserve Delta 2s for commercial satellite owners, including Conel ASC, Hughes Communications Satellite Services, India, Comsat Corp., Innarsat and Pacific Satellite, Inc.

Comsat reserved launches for two satellites and the other companies for one. Two other organizations whose identities are undisclosed also have made Delta reservations. If McDonnell Douglas succeeds in negotiating contracts, it will begin commercial services in December, 1988, with the launch of Conel's ASC-2 satellite. The commercial flight would follow the first Air Force Delta 2 launch, which is scheduled for October, 1988.

McDonnell Douglas will mix commercial and Air Force payloads on the Delta 2 schedule for 1989 and beyond. India has reserved the second commercial slot in March, 1989, followed by Comsat in August of that year, Innarsat in September and Hughes in December, 1989, according to Jack Winfrey, McDonnell Douglas' manager of program development for advanced launch systems.

Delta 2 is capable of 12 missions per year, of which the Air Force is expected to use six through at least 1991. The re-

mainder of the launches would be available to commercial or other government users. Winfrey said McDonnell Douglas market estimates indicate that commercial business will support no more than two or three launches per year in the early 1990s.

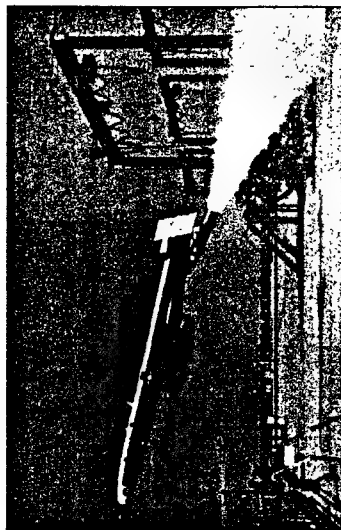
While 6-10 satellites in the Delta 2 class are expected to be launched annually in the early 1990s, McDonnell Douglas expects competition from the Chinese, Japanese, Soviets and Europeans to win a sizable part of the market. Winfrey said that the Japanese may begin marketing the H-2 launch vehicle as early as 1988 for launches following its 1992 debut.

Transpace Carriers has been negotiating with McDonnell Douglas for a role in Delta 2 marketing or financing, but played no role in the signing of the nine reservations, Winfrey said.

He would not discuss launch prices or terms and conditions, due to contract negotiations with several of the customers. However, it is expected that McDonnell Douglas will offer a reflight insurance option to its customers, just as ArianeSpace and Martin Marietta are doing for Ariane and Titan.

Commercial Delta 2s will be capable of launching 3,190-3,560 lb. to geosynchronous transfer orbit. □

Navy Launches Beech BQM-126A Target Drone at Missile Test Center



Navy/Beech BQM-126A target drone, a significantly modified version of the Army/Beech MQM-107, is launched for the first time at the Pacific Missile Test Center at Point Mugu, Calif. The BQM-126A was designed for surface or air launch. The drone will operate at altitudes from near sea level to 40,000 ft. Contractor test and evaluation flights will be followed by a Navy evaluation phase. The BQM-126A for air-launch capability, will replace the Navy's BQM-34S and BQM-74C target drones.

Martin Pursuing 15 Additional Titan Launch Contracts

By Theresa M. Foley

Washington—Martin Marietta, which last month became the first U.S. commercial expendable rocket company to receive a firm launch order, has outstanding proposals for 15 additional satellite launches that the company hopes to convert to contracts by early summer.

Intelsat last month ordered two commercial Titan 3s for launches in 1989 (AW&S Mar. 23, p. 30). Although the final contract has yet to be signed, the sale is expected to be worth more than \$200 million. The two Intelsat 6 satellites each will require a dedicated Titan launch.

Martin Marietta is offering reflight insurance at a 10% premium to its customers, following the lead of ArianeSpace, which was the first launch company to institute an insurance program for its users.

"We have a lot of confidence in our product," Richard Brackeen, Martin Marietta vice president-space launch systems, said.

Reliability Rate

The Titan 3 has a 96.3% reliability rate, but has failed twice in the last 15 months. Martin Marietta officials will not disclose whether the company will purchase reinsurance or use a pool of internal funds for the program.

The insurance will not cover the spacecraft or upper stage costs, nor will it cover the period after separation of the satellite from the Titan. Customers will have to obtain separate coverage for those elements.

Martin Marietta officials consider ArianeSpace to be their main competitor and are taking several steps to improve Titan's commercial attractiveness.

"The score is Titan two, Ariane about 22. But we're going to even that score, I hope," Brackeen said.

Martin Marietta officials also are keeping close watch on the commercial progress of the Chinese in launcher sales. Brackeen said that while the Chinese facilities have been described as "rudimentary," we'd be foolish to count them out as an adversary. He said the Long March 2 is "remarkably similar to Titan 2" and in the Long March 3 growth program, the Chinese are "unabashedly copying the Ariane 2/3/4 concept."

Martin Marietta will recompute the contract for Titan solid rocket motors to lower the cost of a commercial Titan launch and bring newer technology to the design. The company recently asked all major U.S. solid rocket manufacturers to

Toxic Control Rocket Test Facility Planned

Edwards AFB, Calif.—A new toxic control facility capable of handling beryllium-based solid rocket propellant used in kinetic energy weapons is planned for construction on a remote five-acre site here. A contract award to build the 4,000-sq.-ft. complex is expected late this month.

Operated by the Air Force Astronautics Laboratory (formerly the Rocket Propulsion Laboratory), the facility will enable testing of highly toxic rocket propellants without releasing dangerous contaminants into the atmosphere. In particular,

beryllium-based fuels, which offer improved thrust-to-weight benefits for space-based kinetic energy weapons, can be tested under controlled conditions at the site. A totally contained vacuum chamber will simulate exoatmospheric conditions while also containing exhaust products from rocket motor test firings. Exhaust will be routed through a series of scrubbers and filters to remove all but negligible traces of toxic contaminants. Open-air atmospheric tests of rocket fuels containing beryllium were discontinued in the late 1960s.

bid to supply boosters for the Titan 3 and 4 programs under a contract that will be worth hundreds of millions of dollars.

Companies that were sent the request for proposals include United Technologies Chemical Systems Div., the incumbent; Hercules; Morton Thiokol, and Atlantic Research. Proposals are due at Martin Marietta in two months and a winner will be selected by late summer.

Brackeen said goals of the competition are to get an SRM with fewer field joints and to eliminate asbestos-filled rubber from the stage. The new design should provide higher reliability and better performance. The Titan guidance system also is a candidate for recompetition, but that is not planned until 1988 or 1989.

Martin Marietta decided to buy Titan 3 commercial fairings from the Swiss company Contraves after receiving competitive bids for the contract. Contraves will supply the same fairing to Martin as it does to ArianeSpace. Brackeen said the closest competitor was McDonnell Douglas Astronautics Co., which builds fairings for the Titan 2 and 4. He said Contraves offered a better proposal in all evaluation areas—weight, performance, schedule availability, technical suitability and price.

"The Contraves proposal was superior," Brackeen said.

Payload Compatibility

Selection of the same fairing as ArianeSpace should make it easier for satellite owners to design for dual compatibility with Ariane and Titan. Martin Marietta also is considering use of a European-built dual payload adaptor to carry two satellites on one Titan, a step that would further increase its compatibility with Ariane payloads. British Aerospace and Aerospaziale's Spelma designs, which are used for Ariane 4 and 5, are in the running for use with Titan. Decisions on the dual payload adaptor will be made in the fall.

Martin Marietta can accommodate two more satellites on its schedule in 1989 using the commercial 4-meter (13.12-ft.) Contraves fairing, and others—for exam-

ple, a NASA Tracking and Data Relay Satellite—that would not need the fairing. Martin Marietta plans five commercial launches annually for the seven following years, if it can sign up enough customers. "We've received deposits and made proposals for all of the launch slots through about mid-1991," Brackeen said, adding that his company may not win contracts for all of them.

Titan 3 launch facilities are capable of seven missions per year, but Martin Marietta has adopted a conservative approach to scheduling commercial flights because it wants to guarantee that military launch operations on the adjacent Titan 4 pad, which shares some facilities, will not affect the commercial program. "We don't want to get into the business of offering more launches than we can subsequently deliver," Brackeen said. The company also wants to provide some schedule slack in case NASA orders Titan 3s for its payload.

Brackeen said he believes that Ariane and Titan launch prices are comparable. Titan will not pay much more for the Titans than the company would pay under the current ArianeSpace pricing policy, he said.

Following last year's Titan 34D failure, Martin Marietta reassessed Titan's systems to determine if design margins had been encroached on by improvements made over the years. Brackeen said the last failure, in April, 1986, was traced to inspectors missing an inferior part. Investigators determined that the military Titan mission failed due to debonded insulation on one of the solid rocket boosters.

Every flight-critical component of the Titan now is being put through more rigorous testing to reduce the chance of another failure.

Martin Marietta needs to sign a launch vehicle commercialization agreement with the Air Force before commercial contracts can be completed. Brackeen said he expects that to be done within 30 days. Another agreement, for payload processing support, will be signed with NASA headquarters soon. □

EVA Performed To Dock Kvant Module to Mir

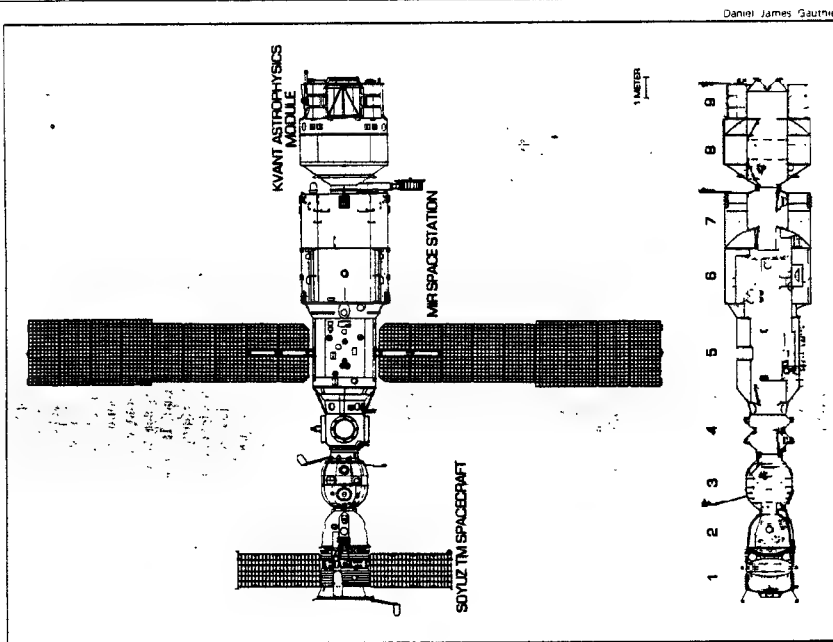
Washington—Soviet cosmonauts Yuri Romanenko and Alexander Lavekin corrected a docking problem between the new Kvant astrophysics module and the Mir space station during an unplanned extravehicular activity Apr. 12 in which they removed an object that prevented the two facilities from making a firm connection.

The object, which the cosmonauts said looked like a small white bag, may have been a protective covering, label or bag that was mistakenly left on Kvant by the ground crew. It prevented Kvant from docking completely with the Mir Apr. 9 when the two facilities linked up (AW&S Apr. 13, p. 27).

During the 3 hr. 40 min. EVA, the cosmonauts separated the two facilities manually by pulling them more than a foot apart and removing the object while the Kvant docking probe remained attached to its connection point with the Mir. The docking then was completed by command from ground controllers.

Kvant's propulsion module, used to maneuver Kvant toward the Mir, was jettisoned Apr. 13. Removal of the propulsion module cleared a docking port on Kvant that may be used for future Progress resupply vehicles. The cosmonauts then opened the hatch between the two facilities, entered Kvant and began preparing the astrophysics instruments for operations.

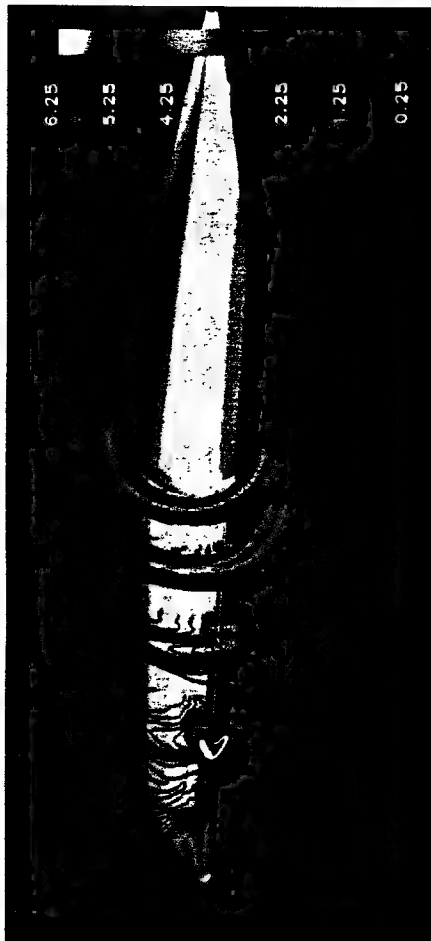
In other activity, the Soviet Union and the U.S. last week signed an agreement on civilian space cooperation (AW&S Mar. 16, p. 26; Nov. 10, 1986, p. 10). The agreement, signed in Moscow by Secretary of State George Shultz and Soviet Foreign Minister Eduard A. Shevardnadze, contained 16 points for cooperation. Highlights of the agreement included potential cooperative activity involving U.S. and Soviet unmanned Mars missions and astrophysics. □



Kvant astrophysics module is now docked with the USSR's Mir space station/Soyuz TM complex in orbit, following the Soviet extravehicular activity Apr. 12 to remove an object that interfered with the connection between Kvant and Mir. Sections of the orbital complex identified in the line drawing are: (1) Soyuz TM instrument module; (2) Soyuz descent module; (3) Soyuz orbital module; (4) Mir multistation section/EVA airlock; (5) Mir command/control section; (6) Mir living quarters; (7) Mir transfer compartment; (8) Kvant control section, and (9) Kvant transfer compartment/docking port.

Daniel James Gauthier

X-30 Research Narrowing Hypersonic Design Options



Computer model of the X-30 National Aero-Space Plane (left) is being generated here by the NASA Ames Numerical Aerodynamic Simulator. The colors show the course of a simulated Mach 25 airflow striking the X-30 nose at right, then moving left over the wings. Such hypersonic cruise and single stage to orbit space flight

craft program initiated after a 20-year hiatus following the X-15. The project is becoming a major factor in rejuvenating U.S. air and space technology.

A detailed X-30 technology development program is beginning nationwide in dozens of NASA, Air Force, Navy, contractor and university laboratories. Seven teams responsible for overseeing critical X-30 technologies have been formed, and the project has identified about 125 critical technology development tasks now starting to be addressed.

The X-30 Joint Program Office at Wright-Patterson AFB, Ohio, has begun coordinating user studies on the operational military and civil vehicles that could be developed as a result of X-30 research. These include concepts for a new strategic reconnaissance aircraft to replace the Lockheed SR-71, a new manned single-stage-to-orbit launch vehicle to replace the space shuttle and civil hypersonic transport concepts.

Program Management

The Defense Advanced Research Projects Agency is in charge of program management. The X-30 program directors for NASA, the Air Force, Navy and Strategic Defense Initiative are based at DARPA in Washington, while technical direction is managed from Wright-Patterson.

Key program factors will be considered in 1989 as part of a final decision on proceeding with the construction of two X-30 research aircraft that could fly as early as 1993.

By Craig Covault
Washington—The X-30 National Aero-Space Plane project to develop a research aircraft with hypersonic cruise and single-stage-to-orbit capability has begun achieving technical milestones and is approaching a key decision, selection of airframe and engine contractors for more advanced design.

The airframe and engine selections will significantly reduce the number of possible X-30 configurations.

The three scramjet engine study contractors—General Electric, Pratt & Whitney and Rocketdyne—are completing preparations for the X-30 engine concept review. The review will begin in June and culminate in August with selection of two of these contractors to continue the concept validation phase of the project.

In addition, five hypersonic airframe study contractors—Boeing, General Dynamics, Lockheed, McDonnell Douglas and Rockwell International—are completing work for the airframe concept review.

This assessment will begin in August and end in October with the selection of three contractors to develop large demonstration hardware.

The \$3.3-billion Defense Dept./NASA program is drawing increased congressional scrutiny and the General Accounting Office has begun a major review of the project. The GAO assessment is due in November. The X-30 is the largest research aircraft project ever undertaken by the U.S. and the first hypersonic X-air-

craft, more than 1 million points on the aircraft," Robert M. Williams, DARPA program manager for the Aero-Space Plane, said.

Wind tunnel models—An X-30 baseline model recently was run to simulate Mach 20 in a NASA Langley Research Center tunnel to help calibrate the computational fluid dynamic codes. By matching the computer models with selected tunnel data more confidence can be gained in the accuracy of computer-generated data that cannot be backed up by tunnel testing prior to the first flight. In addition, tunnel testing of subscale X-30 components will provide engine and airframe data at simulated velocities well above Mach 8, improving confidence in the computer modeling.

Propulsion—Langley recently conducted tests of a ramjet in simulated Mach 3.5 flight conditions. The ramjet now is at the NASA Lewis Research Center for additional testing. The device is being used to examine startup and low-speed engine characteristics. In addition, an X-30 type scramjet inlet combustor recently has been tested at above Mach 10 in a Calspan Corp. tunnel. As with the airframe, a key aspect of the engine hardware tests is calibration of computer-generated codes.

Materials—Advanced materials will be a major technology challenge. X-30 managers cited developments in aluminum/titanium alloys, especially with inclusion of composite materials to increase strength, as of key importance. Several

companies are making progress in this area.

While the Defense Dept. will fund about 80% of the program and NASA about 20%, the space agency's share recently has been elevated for this portion of the concept validation phase. This was done to bring more immediate emphasis on technology development where NASA has the most capability. Excluding salaries, NASA's current share is about 36%, according to Raymond S. Colladay, head of NASA's Office of Aeronautics and Space Technology.

The \$320-million X-30 Fiscal 1988 budget request is \$236 million in Defense funds and \$84 million in NASA funds. Total budget in Fiscal 1989 would be \$411 million with a significant increase after that to build the two X-30 vehicles.

Two of the three engine contractors, Pratt & Whitney and General Electric, each have received \$30 million to reach the engine concept review. They also have devoted significant corporate funding to the project.

Rocketdyne did not receive a government contract but believes the potential value of participation is so important it has devoted just under \$10 million of its own funds to compete. Rocketdyne has been examining a scramjet engine using lower temperatures and with less variable geometry than the Pratt & Whitney and GE concepts.

Aero-Space Plane program managers said all three companies have made progress in component design, structures, and

weight and size tradeoffs during the first half of the concept validation phase.

The two winning engine contractors each will receive an additional \$145 million. In mid-1988 they will participate in a test module review that will examine the total engine design for each contractor. That will be followed immediately by the construction of a high-size engine by each contractor and the firing of those scramjets in early 1989 as a key demonstration for continuing the project.

The three chosen airframe companies will build X-30-type wing leading edges using advanced materials, demonstrate active cooling using the hydrogen fuel and fabricate large, lightweight liquid hydrogen tanks. Each airframe company so far has received \$9 million for its X-30 work. The three winners each will receive an additional \$25.5 million.

If the program proceeds, one engine and one airframe contractor will be selected in 1989. The funding after that decision will represent two-thirds of the total \$3.3-billion projected cost.

All the airframe contractors are pursuing at least two designs.

The final aircraft may not look anything like the Aero-Space Plane baseline that uses a wing/body type design. Three other designs are being studied. These are cone designs with and without blended wing designs, blended body designs where the wing loses its identity relative to a flattened fuselage, and a "cartoon" or "wave rider" design with a rounded body and drooping wings. □

Scientists Find Corporate Support Building for Deployment of SDI

By John D. Morrocco

Washington—The Administration's Strategic Defense Initiative is rapidly gaining momentum among defense contractors but corporate pressure for its deployment has not become irreversibly entrenched, according to a recently released SDI study by the Federation of American Scientists.

The FAS study ranks the 695 corporations, research centers, government agencies and universities that have received at least one of the 3,325 SDI contracts awarded between March, 1983, and March, 1987, in terms of total dollar amount awarded. To date, Congress has approved \$10.2 billion for the SDI program with another \$3.5 billion planned between 1988 and 1992, for a total projected budget of \$40.2 billion. Contracts worth \$10.2 billion have been signed, of which \$3.3 billion has already been obligated.

The study revealed that in terms of geographical distribution, SDI is based upon a fairly narrow foundation of private firms and research organizations with expertise in ballistic missile defense technology. Unlike the USAF/Rockwell International B-1B program, for example, which won large-scale political support by having subcontractors in virtually every congressional district, work on SDI is concentrated in just a few states. According to the FAS study, more than 45% of the total dollar amount of SDI contracts awarded has gone to firms in California, with the Los Angeles area alone making up nearly 25% of the total.

While the imbalanced geographical distribution dilutes potential political support, the large number of companies working on the program has given SDI a broader corporate constituency than the B-1B within the aerospace industry.

According to the FAS study, industry skepticism about SDI continues to revolve around five major considerations:

- The high costs involved in competing for contracts.
- The poor odds of winning a profitable contract.
- An uncertain business environment owing to constant program restructuring.
- The high risk of program cancellations owing to technical problems or changes in priorities resulting from budget constraints.
- The uncertain future of the entire program given the possibility of an arms control agreement with the Soviet Union.

But corporate interest in SDI remains high as evidenced by the establishment of special SDI divisions and the contracting offices within corporations and the acquisition

Top SDI Contractors

Company	Number of Contracts	Total Value Of Contracts 1983-87	Total Obligations 1983-86
Lockheed	59	\$1,023,829,473	\$310,190,636
General Motors	97	733,739,890	269,761,084
TRW	86	567,151,136	335,244,167
DOE Lawrence Livermore NL	72	552,356,000	363,641,000
McDonnell Douglas	48	485,085,742	226,587,549
Boeing	55	474,742,928	274,815,521
EG&G	4	467,500,000	252,050,000
DOE Los Alamos Nat'l. Lab	38	457,891,000	287,891,000
General Electric	53	420,490,994	60,401,980
Rockwell International	82	368,658,644	163,030,238
MIT	24	352,584,000	168,416,000
Raytheon Co.	20	247,911,289	72,103,089
LTV Corp.	21	227,345,403	105,126,252
DOE Sandia Nat'l. Lab.	19	217,470,000	145,470,000
Fluor	1	197,636,000	2,725,000
NASA	16	194,269,000	194,169,000
Grumman	11	193,298,669	38,975,083
Gencorp Inc.	32	190,684,869	80,193,693
Teledyne Inc.	27	188,620,308	149,493,480
Honeywell	40	150,896,700	46,723,444
Martin Marietta	60	134,229,363	110,041,389
SDI Institute	1	125,000,000	—
Textron	35	118,017,021	58,184,365

Figures are from Federation of American Scientists' study on SDI contracting.

tion by large companies of smaller firms that specialize in SDI technologies. The recent push for early deployment has reversed industry's interest since it would result in large procurement contracts for an operational system, an arrangement far more lucrative and stable than less profitable and riskier research contracts, the study said.

According to the study, private firms make up the largest group of SDI contractors with 331 separate firms sharing 73% of the total dollar amount of SDI contracts let between 1983 and 1986. Heading the list is Lockheed Corp. with 59 contracts valued at more than \$1 billion, followed by General Motors with 97 contracts valued at \$730 million.

The next largest group includes 15 federally funded research and development centers that make up 14% of the total dollar amount of SDI contracts. The top three laboratories are Lawrence Livermore (5.1%), Los Alamos (4.2%) and Sandia (2.0%).

Universities make up 6% of the amount of SDI contracts. A total of 350 contracts with an average value of \$1 million have been let to 80 universities, with the Massachusetts Institute of Technology's Lincoln Laboratory (3.2%) and the Johns Hop-

SDI Finds Staged Deployment Would Inhibit Soviet Attack

By Brendan M. Greeley, Jr.

Washington—Deployment of the initial phase of a layered ballistic missile defense could severely restrict Soviet attack timing by denying launch window constraints and confounding assignments for weapons targeted against hardened U.S. facilities, according to last week's Strategic Defense Initiative 1987 report to Congress.

Incremental deployment "is the only likely means of deployment," but no decision has been made nor has the program been restructured to implement any such deployment, USAF Lt. Gen. James A. Abrahamson, SDI director, said while discussing the report.

A recent congressional staff report alleging that SDI has been covertly reoriented from antiballistic missile research to possible early deployment of a strategic defense is "false," according to an SDI official (AWST Apr. 13, p. 24). A milestone 1 decision on whether to proceed from the present concept evaluation phase into the demonstration and validation phase of the overall SDI program is possible this summer, Abrahamson said.

Given a decision to deploy a defensive system, a first deployment phase of what might eventually become a layered ballistic missile defense could use kinetic energy weapons and known sensor system technologies to concentrate on destroying targets in the boost, post-boost and late-midcourse intercept layers. The boost and post-boost layers might consist of space-based kinetic-kill interceptors combined with surveillance and targeting sensors in geosynchronous orbit. The late midcourse phase intercept layer could consist of ground-launched interceptors, combined with ground-launched surveillance probes, according to the report.

Specific Objectives

Subsequent phases would be given the size and capability to achieve specific military and policy objectives, and there is no reason to consider SDI as a given number of weapons and sensors, according to Abrahamson. The system will evolve, he said, and its configuration will depend on Soviet reactions. "SDI responds to the threat and is not a fixed system," Abrahamson said. If the Soviets attempted to develop fast-burn boosters to counter U.S. deployment of space-based kinetic-kill vehicles (SBKRVs), the U.S. might then demonstrate a directed energy capability to cope with the boosters, negating further developments by the Russians in

this area, Abrahamson said by way of example.

SDIO does not plan to use the space station during the research phase, according to Abrahamson.

Depending on Soviet responses to first-phase deployment, a second phase might augment late-midcourse and boost layers with space surveillance sensors and upgraded battle management capabilities. Increased numbers of space-based kinetic-kill vehicles could provide the space-based systems with self-defense against Soviet antisatellite weapons.

A third phase could employ advanced systems capable of attacking ballistic missiles throughout their entire flight trajectory.

Red/Blue countermeasures teams are

LTV Missiles Group Wins Ernt Contract

Dallas—LTV Missiles and Electronics Group has received an \$80-million, three-year contract for continued development of extended-range intercept technology (Ernt) for the antiballistic missile defense program sponsored by the Strategic Defense Initiative.

Ernt is an extended-range version of the Army's flexible lightweight agile guidance experiment (Flage) program, which is aimed at validating technologies to assure that guidance accuracy would permit nonnuclear intercept of tactical missiles within the atmosphere. The Flage program originally was known as small radar homing intercept technology.

The Defense Dept. said LTV would modify Flage technologies with increased radar seeker performance, a reduced weight warhead with a fuzing function, larger attitude control motor and a more powerful rocket motor. While Flage intercepts have taken place at lower altitudes, such as 12,000-15,000 ft., Ernt is designed for intercepts at higher altitudes, such as 35,000-50,000 ft., and at higher velocities.

Under the contract, which runs through April, 1990, LTV will perform six test flights to demonstrate Ernt's ability to home in on and destroy tactical targets. Flight tests are expected in 1989.

The Flage and Ernt programs began in 1983. To date, six of nine Flage test flights have been performed. The remaining three will be against ground-launched targets such as the Lance, which is similar to Soviet short-range tactical ballistic missiles.

Three Classes

Three classes of ballistic missile defense architectures have emerged:

- Combined architecture class using both space- and ground-based sensors and weapons.
- Ground-based kinetic energy weapons class.
- Regional defense architecture to counter short-range tactical ballistic missiles.

In the combined and the regional architectures, the basic versions rely on kinetic energy weapons while the more advanced versions would integrate directed energy weapons into the overall defense.

The report emphasizes the need to establish a Strategic Defense Initiative Institute to provide unbiased technical advice. Establishing a new federally funded research and development center would be slightly more expensive than using some of the other options considered but the benefits "far outweigh any differences in cost," according to the report. Funds to establish this center have yet to be authorized by Congress.

Surveillance, acquisition (including battle management) and intercept remain the fundamental requirements in any given layer of a ballistic missile defense.

In the boost phase, the SDIO has confidence that technology is available to develop the required surveillance and acquisition sensors. Generic weapons concepts but would be used for the intercept include thermal kill lasers, particle beams and kinetic energy projectiles such as chemical rockets and electromagnetic guns.

In the post-boost phase, when reentry vehicles and decoys are still packed to-

USAF, Aerojet Revive Concept Of Integrated Rocket Stages

By Richard G. O'Lone

San Francisco—The Air Force and Aerojet General have revived the integrated stage concept that allows more efficient packaging of multistage solid rockets and is expected to produce performance, reliability and cost improvements in weapons systems—particularly ballistic missiles.

The concept, first explored for liquid-fuel rockets two decades ago, has been given new life in recent years by propulsion and material improvements, which in turn have allowed use of nozzles one-third the conventional length. This is the key element that permits the nesting of first and second stages, eliminating the need for an interstage linking the two.

The Aerojet Strategic Propulsion Co. recently was awarded a \$10-million contract to continue work it began in 1979 on the integrated stage concept. Between 1979 and 1981, the company spent a "substantial amount" of its own funds on the

effort, USAF officials said. Government support began in 1981 and has amounted to \$2.5 million, they said.

The program has been highlighted by three firings, called Super BATHS (ballistic and test evaluation) motor tests, in the Air Force Astronautics Laboratory high altitude facility at Edwards AFB, Calif.

The recently launched five-year effort is expected to culminate in two or three firings of a more complete motor system. Lt. Rich Walker, Astronautics Laboratory integrated stage program manager, said past work with Aerojet has been devoted to developing and demonstrating the individual technologies required by the concept. "The objective now is to tie together the work that has been done in the past, bring it into a motor environment and test it as one integrated system, using near-flightweight components," he said.

The concept's three primary advantages—increased performance, lower cost and higher reliability—represent an un-

Panel Disputes SDI Timetable

The panel's report was reviewed and approved by a six-person committee that included Charles H. Townes and Arthur I. Schawlow, both Nobel laureates for laser research.

The APS study group acknowledged that "predicting the course of technological progress can be particularly difficult." It noted that "very optimistic predictions often are made for technologies or schemes that are at very early stages of development."

The study pinpointed "significant gaps in the scientific and engineering understanding of many issues." The panel added that "successful resolution of these issues is critical for the extrapolation to performance levels that would be required in an effective ballistic missile defense system."

The APS panel noted that the "most crucial elements required for a DEW [direct energy weapons] system need improvements of several orders of magnitude."

"At present, there is insufficient information to decide whether the required extrapolations can or cannot be achieved," the report said.

The APS study group concluded that DEW technology faces so many challenges at this point that "deployment of a substantial DEW component in a ballistic missile defense system cannot be foreseen before the year 2000."

Washington—Another decade of intensive research in lasers and other directed energy weapons will be needed before an "informed decision" can be made as to their potential effectiveness for ballistic missile defense, according to a 21-month study by an American Physical Society panel.

The originally stated objective of the Strategic Defense Initiative program was to enable a future president and Congress to make such a decision by the early 1990s.

The 17-member panel, which included several scientists at government laboratories who work in the directed-energy field, was given access to classified information to aid in making a realistic assessment.

The APS group focused its study on the science and technology of directed energy weapons and did not consider kinetic energy weapons. The panel also intentionally avoided the issue of whether an SDI type system could be cost-effective or should be deployed.

Despite the controversial subject, there was sufficient agreement among the diverse panel members to enable their findings to be published without any dissenting minority report. The panel was headed by Kumar Patel of AT&T Bell Laboratories and Nicolaas Bloembergen of Harvard University, who received a Nobel prize for his early research in lasers.

missiles carry a single warhead rather than the multiple-warhead payload of an ICBM.

The governments of the United Kingdom and Israel and seven multinational contractor teams are conducting theater architecture studies under SDI research awards (AWARD Dec. 8, 1986, p. 18).

The surveillance, acquisition, tracking and kill assessment program element continues to receive the single largest allocation of funds since this technology is fundamental to all layers of any ballistic missile defense. Research is focused on radar and optical discrimination, imaging and laser radar, infrared sensing, interceptive discrimination and signal processing.

Significant directed-energy experiments are being given priority in order to improve boost-phase intercept and midcourse discrimination capabilities. Key technology integration experiments include:

- Ground-based free electron laser.
- Neutral particle beam integrated space experiment.
- Space pointing and tracking experiments.
- Both shuttle-launched (Starlab) and expendable-vehicle-launched (Pathfinder) experiments are under way.

Kinetic Program

The kinetic energy weapons program is defining a space-based kinetic-kill vehicle (SBK-KV) experiment, continuing work on the Army/McDonnell Douglas high endoatmospheric defense interceptor (HEDI) and the Army/Lockheed exoatmospheric reentry-vehicle interceptor system (ERIS), and is developing miniature projectiles for ground- or space-based systems. The Sagittar and Grenlin programs have been combined to form a single research effort into lightweight exoatmospheric advanced projectiles.

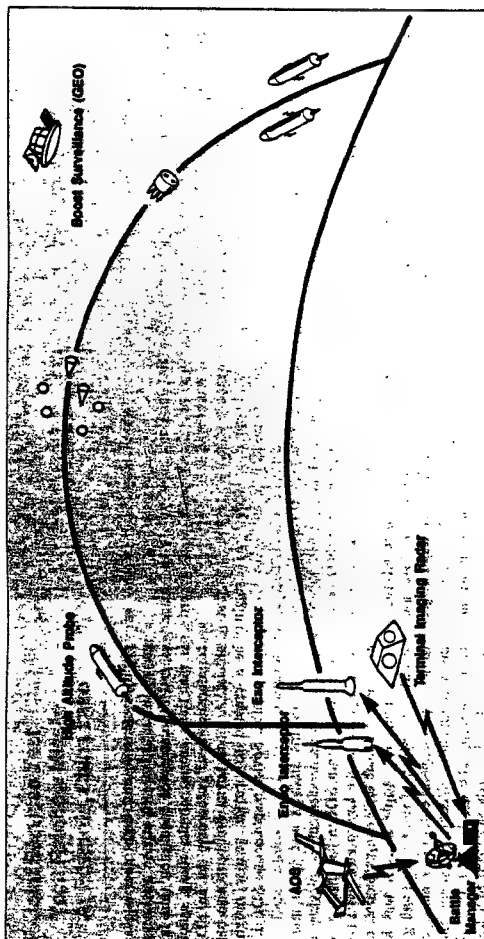
SDI plans to test fully functional projectiles by the summer of 1989. The Air Force Armament Laboratory is conducting hypervelocity launcher research.

The next significant technical milestone flight, Delta 181, is scheduled for Fiscal 1988 to collect the data required to support the space-based kinetic kill vehicle early flight experiment.

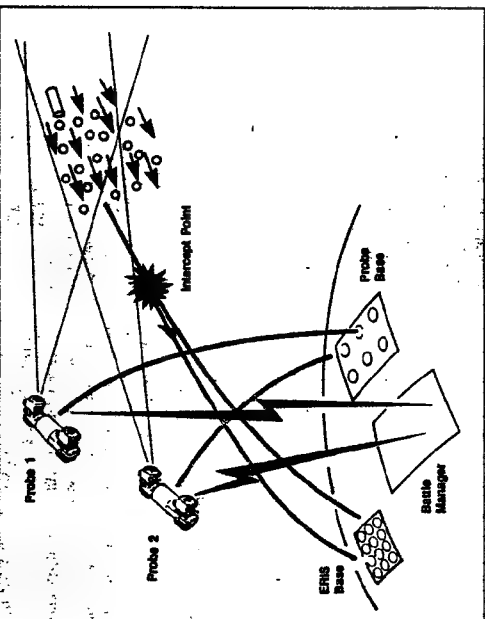
The kinetic energy weapons program element also is conducting research into theater missile defense via a foreign technology effort. The United Kingdom is concentrating on electromagnetic railgun technology. Israel is evaluating a combined chemical and electrical propulsion scheme and Italy is developing a pop-up exoatmospheric millimeter-wave radar system.

Letality testing is continuing at White Sands Missile Range and Brookhaven and will begin at Los Alamos National Laboratory this year.

All test results are being compiled into a lethality assessment that will be revised annually. [E]



Artist's concept above shows a ground-based kinetic energy weapons architecture that, except for a small number of surveillance satellites, relies on active elements not deployed in space. High-altitude sensor probes pop-up on launch warning and coordinate exo-intercept for attacks against reentry vehicles. An airborne optical surveillance (AOS) platform is equipped with wide field-of-view, high-resolution sensors that are essential for late-midcourse and terminal detection, discrimination and designation of reentry vehicles. The AOS hands off data to the terminal imaging radar, which in turn coordinates attacks by endo-interceptors. Battle manager controls overall defensive system. At left, ground-based probes with long-wave infrared sensors could be launched to supplement the space surveillance and tracking system, which has been delayed by lack of funding. The probes would coordinate attacks by the Army/Lockheed exoatmospheric reentry-vehicle interceptor system (ERIS), which is also ground-based. Artist's concept depicts an engagement during the late-midcourse portion of incoming reentry vehicles and decoys.



The SDIO is emphasizing use of a neutral particle beam for what it calls "interceptive discrimination," and believes that a reliable midcourse discrimination capability can be developed before 2000.

The particle beam test facility at Brookhaven National Laboratory, which became operational last year, will be used for future interactive discrimination experiments.

Technologies to support a terminal phase "are well defined and relatively mature," as a result of research that dates back to the 1950s. An airborne optical surveillance system would detect incoming reentry vehicles and decoys.

reentry vehicles and initiate tracking on those above an established threshold. Ground-based interceptors would be used extensively in this phase.

Submarine-launched ballistic missiles (SLBMs) and intermediate-range (IRBMs) and tactical ballistic missiles pose special problems for defensive systems. The lower apogees associated with some IRBMs or apogees associated with some IRBMs or with depressed-trajectory SLBMs make midcourse intercept difficult. Slower reentry speeds and fewer penetration aids and decoys might provide offsetting advantages for a defensive system, according to the report. In addition, most shorter-range

FBI Investigating Fraud Charges Against Morton Thiokol in Manufacture Of Shuttle Solid Rocket Motors

Washington—Morton Thiokol is under criminal investigation by the FBI for alleged fraud in connection with its manufacture of space shuttle solid rocket motors for NASA, documents.

The documents are associated with civil litigation resulting from the Challenger accident.

Morton Thiokol employees visited FBI agents in Salt Lake City on Jan. 15 to make "substantial allegations of fraud" against Thiokol, sparking an investigation that is directly related to allegations that the company has misled and cheated the government made by former Thiokol engineer Roger Bosjoly in his civil suit.

Bosjoly filed two suits against Morton Thiokol in January, although the second was not revealed until April. The first is a private suit, charging NASA and Thiokol with allowing the Challenger launch despite the "unanimous position of the Thiokol engineers that it was grossly unsafe to fly," and Thiokol then undertaking a program to discredit Bosjoly and other engineers who warned against flying.

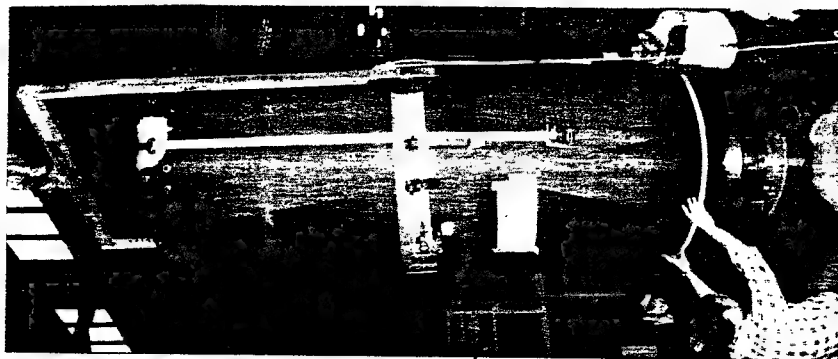
The second suit was filed under the False Claims Amendments Act, a new law that allows private parties to seek redress against persons who have allegedly cheated the government. Such a lawsuit is known as a "qui tam" action and allows the plaintiff up to 25% of any award, which must be shared with the government, that results from such an action.

Bosjoly's second complaint, which was made public Apr. 2, charges Thiokol with falsely certifying the safety of the Challenger launch with the motivation of pre-

venting "Thiokol's unlawful monopoly as the sole source provider" of shuttle SRMs. The complaint asks for more than \$2 billion in compensatory damages and an identical amount in punitive damages.

In a statement disclosing evidence related to the lawsuit, Bosjoly charges that Thiokol on several occasions withheld shuttle SRM O-ring test results and other information from NASA for several months in 1985. Thiokol management also withheld essential information from its own engineers that would have led to the conclusion that shuttle flights must be stopped until O-ring problems were resolved, Bosjoly charged.

Bosjoly said he believed that Thiokol



Hercules Fabricates Test Article for Delta Strap-on Boosters

Hercules Aerospace is fabricating test articles of graphite epoxy case strap-on booster motors for the McDonnell Douglas Delta 7920 launcher which will be lighter than the Thiokol Castor steel case strap-ons used on current Delta models. Motor case shown here is a full-diameter, short-length test article made at Hercules' Bacchus Works near Salt Lake City, Utah. The Delta 7920 is set to fly in early 1990 and Hercules has a \$70-million contract for development and production of 99 strap-on boosters. Air Force decision on whether to stretch the boosters 6 ft. is expected in May.

fewer parts, which increases reliability and decreases costs, he said. Manufacturing costs can be reduced further because the geometry of the stages is such that a single large case can be wound and later divided into two motor cases.

Key integrated stage elements include:

- **Forced deflection nozzle**—This nozzle, with six holes spaced 60 deg. apart, deflects the motor exhaust along the exit cone's interior walls. This directs the flow straight back, providing greater thrust than with a conventional short nozzle, where the exhaust expands rapidly outward.

- **Propellant**—The concept could not work without the clean, low-oxygen (CLO) propellant that represents a substantial advance in this technology. Low-oxygen content is required because this element erodes on contact with carbon/carbon components. "Clean" refers to minimal production of particles that condense as the gas cools and could erode nozzle components.

- **Hot gas valve**—As the nozzle of an integrated stage is fixed, conventional thrust vector control methods cannot be used. Instead, propellant gases are injected by carbon/carbon hot gas valves into the exit cone, deflecting the motor plume and causing the rocket to change direction. This also is an old idea that has become practical through advances in materials. The valves have been tested extensively in a special fixture at the Astronautics Laboratory.

Work so far has been directed at ballistic missile applications, Walker said, and initial efforts were directed at a small ICBM third stage. "But the primary benefits are to any system that is volume-constrained," he said. "You can put more energy into the same area as a different system, or into a smaller package." For example, if an integrated stage vehicle of the same dimensions replaced the Boeing/Air Force merial upper stage (IUS) in the shuttle bay, "we could get a substantial payload increase," he said.

Biggest Payoff

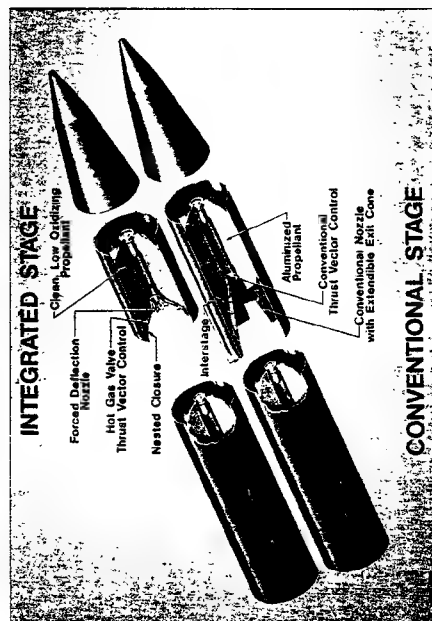
While the concept could be applied to existing systems, the biggest payoff is expected to be in designing a new system to use the integrated stage. Candidates include an advanced intercontinental ballistic missile, a strategic air-launched missile, an advanced fleet ballistic missile and an orbital transfer vehicle.

At the end of the advanced development phase, the Astronautics Laboratory hopes to hand the program off to USAF's Ballistic Missile Office, Walker said. "We bring technology to the level where the system program offices can assume the work," he said.

The objective is to have the concept ready for full-scale engineering development by the early 1990s. □



Forced deflection nozzle and hot gas valve system—key elements of the integrated stage concept—were tested (above) during firing of a 1,000-lb. (propellant weight) motor in the Air Force Astronautics Laboratory's high-altitude test facility. The "shock diamond"—the hexagonal shape at the 2 o'clock position—reflects the nozzle's six discrete throats. Drawing below shows how the shortened integrated stage nozzle allows nesting of the first and second stages, eliminating the need for an interstage. This improves performance and reliability.



usual clustering of benefits, according to Greg McParland, Aerojet's program manager for advanced technology and planning. "Increased performance usually has a price, but this is cheaper," he said. "I know of nothing else where all three key system drivers go in the same direction."

The integrated stage concept results in

Defense Dept. Backs Down On International Station Demands

By Theresa M. Foley

Washington—The Defense Dept. backed down from its dispute with NASA and the State Dept. over international space station agreements during an April 16 White House meeting, clearing the way for negotiations with the Europeans, Japanese and Canadians to resume in May.

The three U.S. agencies reached agreement on a new draft document to present to the partners that NASA officials believe will protect U.S. interests, including those of the Defense Dept. The new intergovernmental agreement represents a compromise in some areas, but also the deferral of much of the controversy to a subsequent memorandum of understanding.

U.S. officials defused the most contentious part of the dispute—agreement language that explicitly reserved the right of the U.S. to use the station for national security purposes—by removing that language and attaching it as a separate mini-

agreement addressing defense rights.

The Defense Dept.'s abrupt change of position alleviated the need, at least for the time being, for President Reagan to choose between an international or a NASA/military space station program.

NASA officials said they were prepared to go to the President following the April 16 meeting if the military held firm on its station demands (ENR April 20, p. 18). Space agency officials said they hoped the concession on the part of the Defense Dept. would mark the end of the Pentagon's interference with the international negotiations, but congressional staffers and industry officials said they expect Defense Dept. influence on the station to continue and probably to grow. "The issue is not over yet," a congressional aide said.

Defense Dept. officials softened their position after "recognizing that the troops weren't rallying around them. The National Security Council wasn't behind them," the staffer said. Defense officials realized that pushing their position would have forced NASA to take the dispute to President Reagan, and they were not confident that Reagan would side with them, according to NASA and congressional officials.

A new draft of the 20-page intergovernmental agreement was sent to the Europeans, Canadians and Japanese on April 20, clearing the way for bilateral negotiations with the U.S. to resume. A one-paragraph attachment, called the "Agreed Minute," refers to national security use of the station.

Agreement Language

"The partners recognize and agree that the U.S., Europe and Japan each will be the judge of what activities on their respective elements of the international space station complex fall within the requirement that all utilization will be for peaceful purposes in accordance with international law," the Agreed Minute said. "Such utilization may include national security use. Further, each partner may make its use of the space station infrastructure, including the [mobile servicing system], in accordance with its interpretation of the above requirement."

Small auxiliary agreements that isolate extremely sensitive issues are not uncommon for international accords, an official familiar with diplomatic procedures said. "If you have an unpleasant clause and do not want it to be a highlight of the public debate [over an agreement], then you do not put it in the main agreement," he

Europeans Disagree On Future Station Negotiation Plans

By Jeffrey M. Lenorovitz

Paris—France is pressing for development of an independent European space station facility if a satisfactory cooperation with the U.S. on the NASA/international station is not worked out, while Germany and Italy are supporting a continued dialogue with the U.S. in an effort to save the cooperative facility.

French officials believe the main effort should be on building the European Space Agency's Columbus man-tended free-flyer laboratory facility, which would be serviced by the Hermes manned spaceplane. The free-flying laboratory would serve as an extremely stable, disturbance-free platform for automated microgravity experiments, and would be unmanned except when boarded by astronaut crews while it is docked to the Hermes spaceplane. Servicing by Hermes is planned at six-month intervals.

Definition Study Elements

The German-led man-tended free-flyer is one of three basic elements undergoing definition studies in the Phase B2 of ESA's multimillion dollar Columbus program. The other two are the Italian-backed pressurized laboratory module, which would be permanently attached to the NASA/international space station, and a large polar platform proposed by the British, which would be equipped with instrumentation for remote sensing, weather monitoring and other tasks.

Frederic d'Allest, head of the French CNES national space agency, said Europe is coming to the realization that an independent capability built primarily on the man-tended free-flying laboratory presents a sound approach that is within ESA's financial and technical capabilities. He said a consensus on this point was reached at a recent ESA management council meeting in Vienna, and the idea has gained even more support since then.

"We are realizing more and more that perhaps the best way to go is to develop our own man-tended free-flyer, and then see how we can cooperate with the U.S. on a less integrated means perhaps through the exchange of experiments, equipment and data."

This view was questioned by West Germany, which continues to place a high priority on working out an agreement with NASA that will allow the ESA pressurized laboratory facility to become part of the international space station.

One official at the BMFT German research and technology ministry said he was confident that a satisfactory ESA con-

■ Details on crew selection and allocation of crew time have been deferred to the MOU.

Frank Gaffney, deputy assistant secretary of Defense for nuclear forces and arms control policy, has represented the Defense Dept. during much of the interagency debate on the station. Gaffney was nominated April 17 by President Reagan for promotion to assistant secretary of Defense for international security policy, replacing Richard Perle, who has resigned. Gaffney and Philip H. Kunsberg, assistant deputy under secretary of Defense for policy, have played influential roles in shaping the Defense Dept. position on station negotiations, according to other government officials involved in the interagency review.

In other activities, NASA officials said the release of the station requests for proposals was expected any day. NASA officials and House Appropriations Committee staffers last week were discussing conditions that the space agency must meet on the station before the committee will release \$150 million in fiscal 1987 funding for station contracts.

Navy Awards F404 Buy To General Electric

Washington—The U.S. Navy has awarded General Electric approximately 70% of its fiscal 1988 F404 engine buy but still is negotiating the quantity that will be produced by Pratt & Whitney as the second source.

General Electric will produce 141 F404-GE-400 engines for the Navy/McDonnell Douglas F/A-18 Hornet, 22 F404-GE-400 engines for the Navy/Grumman A-6F Intruder and 133 F404-GE-400/400D modules as spares. Total Navy requirements for the fiscal 1988 buy are 168 installed engines, 33 spares and 99 modules for the F/A-18 and 24 installed engines, 8 spares and 34 modules for the A-6F.

The Navy has delayed award of a contract to Pratt & Whitney pending the outcome of cost negotiations, according to industry officials.

The company has passed three Navy production readiness reviews and is assembling its first two engines for delivery to the service. When these engines complete tests for performance, durability and conformance to specifications, Pratt & Whitney will be considered fully qualified for F404 production. A Navy official said.

an auxiliary agreement is a standard method for getting around problems such as the one posed by military use of the station and generally is considered to be as binding as the overall agreement, he said, but may not attract as much attention as the larger document.

The intergovernmental agreements (IGAs) are being worked out at the State Dept. level. Memoranda of understanding also are being negotiated between NASA and the corresponding space agencies of each partner. If the IGAs now are more acceptable to the partners, it is largely because many of the controversial points have been moved to the MOU.

Initial Reaction

Initial reaction by some of the partners to the new intergovernmental document was positive. "The basic approach has been to eliminate problems on the level of the IGA, but that leaves open the question of to what extent they will show up in the MOU," one European official said. While the partners are likely to find it easier to accept the new intergovernmental agreements, they also may insist the IGA and MOU documents be tabled together.

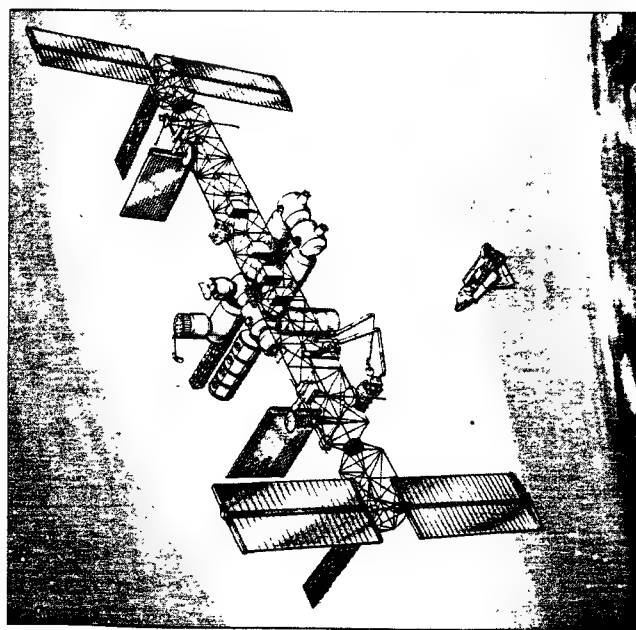
Other key changes to the IGA included:

- References to a multilateral board, chartered by NASA, to manage station activities have been deleted. The new agreement, while referring to management bodies in which the partners would participate, gives NASA overall responsibility for managing the station's manned core and the U.S. unmanned elements, while the European Space Agency would manage its detached elements.

- The new agreement does not identify a mechanism for deciding a dispute among the cooperating agencies, deferring that controversial item to the MOU. The partners objected to an arrangement proposed earlier by the U.S., under which NASA would have the final say on management issues that could not be solved by consensus, while the Defense Dept. demanded that the U.S. not give in to a multilateral decision-making process.

- Details on station operations, another area of keen interest to the Defense Dept. and the partners, are deferred to the MOU.

- A one-sided veto, under which the U.S. could veto activities by the partners on grounds of national security or foreign policy concerns, has been omitted from the new version. No comparable right was provided to the partners. This is considered a major improvement by the partners, a European official said.



NASA's space station, at the completion of Phase 1 in the mid-1990s, would include four pressurized modules attached to a central truss structure with photovoltaic solar arrays, several exterior payload attachment points and a mobile servicing system for limited servicing tasks. The space shuttle, with payload bay doors open for a docking, is depicted in the background of this McDonnell Douglas artist's concept.

received money from NASA to hire 18 quality control and safety workers, but did not hire the safety inspectors and instead used the money as a "slush fund."

He also said that Thiokol had covered up the fact that SRM elements did not meet contract specifications by rewriting analytical models. Bosjop mentions "evidence of improper contractor influence," citing as an example that the chair and vice chair of the SRM source evaluation board that selected Thiokol were former Thiokol employees.

Morton Thiokol last week denied the allegations. It offered to cooperate with the FBI probe and said an internal company investigation had been started, but that no evidence of wrongdoing had been uncovered. Thiokol's strongest denial was of the "slush fund" charge, which it termed a "totally reprehensible falsehood."

Despite legal and contractual problems resulting from the Challenger accident, Morton Thiokol continues to report favorable earnings. Thiokol's third-quarter earnings statement said that its Aerospace Group remained profitable, despite a \$10-million fee reduction resulting from an agreement with NASA modifying the SRM contract. □

Image Shows Hermes Pressure Distribution



Pressure distribution on Europe's Hermes named spaceplane during hypersonic flight is shown in a computer-generated image from France's Onera. Hermes has been part of Europe's space program planning, which includes European participation in the NASA/international space station and development of the heavy-lift Ariane 5 launcher.

operation with NASA could be worked out, and was even more optimistic based on what was understood to be the wording of a new domestic U.S. intergovernmental agreement on the space station, which was approved earlier this month by NASA, State Dept. and the Defense Dept. Copies of the U.S. agreement were being delivered to ESA headquarters in Paris and to its member nations in Europe late last week.

"We are not considering the idea of dropping the European pressurized module for the NASA space station. If this happens, the Columbus program will have to be examined again," the official said. "The French obviously are looking at the possibility that an agreement will not be worked out with the U.S. on space station, and they plan to step in to 'save us' with their Hermes and the man-tended free-flying laboratory. We obviously will consider such an alternative if everything falls apart with the U.S., but our main plan is to move ahead with the U.S. cooperation."

Space station negotiations between the U.S. and its foreign partners had been postponed by the U.S. earlier this month for the second time because of the dispute between NASA/State Dept. and the Defense Dept. over proposed language in the intergovernmental agreement concerning national security use of the station (awx31 Apr. 20, p. 18). The postponement followed a letter by Defense Secretary Caspar Weinberger which included statements that the U.S. should not make concessions to its international partners on the station.

44 AVIATION WEEK & SPACE TECHNOLOGY/April 27, 1987

been significantly revised, mainly because of crew safety considerations in the wake of the NASA Challenger space shuttle accident (awx31 Mar. 30, p. 26).

"I'm more concerned about the technical state of Hermes than the NASA-ESA space station negotiations. We're turning the whole idea of Hermes around, and we're not sure where it is taking us," the manager said. "The French will be pushing very hard to go ahead with the man-tended free-flying laboratory, since servicing of the laboratory by Hermes is one of the few real tasks that remain for the spaceplane now that it has been redesigned."

Hermes will be one of the key topics of discussions at ESA during the coming weeks. A European task force has been formed to review how Hermes' design changes will affect its space servicing tasks and to look at its overall coherence with the Columbus program. The task force's report is due in mid-May.

The subject of Hermes also is expected to be raised during an ESA meeting Apr. 30 of the working group that is making preparations for the European ministerial space summit later this year. The summit, now targeted for November, will consider approving a long-term program package deal that includes the Columbus project, the Ariane 5 heavy-lift launcher and Hermes.

The ministerial meeting had been planned for this summer, but uncertainty over the ESA-NASA space station cooperation and the redesign undertaken for Hermes led the meeting to be postponed until early November.

European officials noted that the overall ESA long-term space planning is in a chaotic state, but acknowledged that such a situation is not surprising based on the complex process now under way to work out a 10-20-year plan that is acceptable to its member states and that also involves cooperation with the U.S.

"We need a time of chaos before the creativity takes over, especially when Europe has to make a major multinational decision such as the long-term space plan," one German diplomat said.

Most European politicians agreed, however, that the situation is not being helped by the factors in Washington who are waging what several called a "guerrilla warfare" over the Defense Dept.'s role in NASA's space station.

"For the French, I don't think Defense Secretary Weinberger's letter could have come at a more opportune time than if they had planned it themselves," one official said. "It played right into the hands of those who have been saying the time is ripe to go it alone on the free-flyer."

D'Allest noted that France had long believed the U.S. would restrict access to the space station, and the recent Weinberger letter confirmed these suspicions.

Top Space Scientists Resign Following Criticism of NASA Policy

Washington—Two top U.S. space scientists serving in advisory positions to NASA, Thomas Donahue and Peter Banks, resigned the chairmanships of their respective groups in the last few weeks, after issuing statements critical of NASA policy and the space station.

Donahue resigned as chairman of the National Academy of Sciences' Space Science Board Apr. 10, but was reinstated Apr. 15 after resolving a disagreement with Frank Press, head of the NAS, the academy confirmed last week. Prior to his resignation, Donahue sent a cover letter and report to some members of Congress that called for urgent action by NASA to provide expendable launch vehicles for space science missions.

In the letter, Donahue said the acquisition of expendables for science missions clearly had higher priority than an as yet "poorly defined space station," one of

the letter's recipients said. Donahue resigned after Press objected to the letter, on the grounds that it had not gone through the proper approval process.

Peter Banks, chairman of NASA's Task Force on the Scientific Uses of the Space Station, also resigned his position (awx31 Apr. 13, p. 28). Banks has been critical of station planning, saying the schedule for operations should be accelerated and a heavy-lift launch vehicle should be used in the program.

NASA is developing an operating plan that calls for the purchase of four ETVs—two Delias and two Titans—in the near future for civilian missions. However, the plan fails to identify a source of money for the boosters, a NASA official said. The plan would respond on paper to the science community's demand, but unless it is accompanied by funds, cannot be enacted, he said.

24 AVIATION WEEK & SPACE TECHNOLOGY/April 20, 1987

Scientists Discover Potential Problems With Ground-Based Free-Electron Lasers

Potentially serious obstacles to propagating a ground-based free-electron laser beam through the atmosphere to space for ballistic missile defense have been discovered by Lincoln Laboratory scientists recently, but their theoretical studies have not yet been confirmed via experiments.

The problem involves the interactive effects of atmospheric turbulence and what is called thermal-blooming, which results from laser energy heating the atmosphere when a beam passes through. Thermal blooming causes distortion and defocusing of a laser beam.

Experiments conducted in 1985 using sounding rockets and the space shuttle indicated that adaptive (flexible) optics could be used to compensate for atmospheric turbulence. But the energy level of the laser used was much too low to cause thermal blooming effects.

Analyses performed by Lincoln Laboratory scientists several years ago indicate that the problem might be severe for shorter wavelengths of about one micron, expected to be used by ground-based free-electron lasers, because of the interaction of turbulence, thermal blooming and Fresnel diffraction.

At the time, however, Lincoln scientists were optimistic that it would be possible to use adaptive optics to correct the problem. But more recent analysis raises doubts that adaptive optics can correct the complex, nonlinear condition.

To fully resolve the issue will require experiments performed with a reasonably high-energy laser operating at shorter wavelengths. But there are no free electron lasers operating at wavelengths of about one micron at present that can generate sufficiently high power.

28 AVIATION WEEK & SPACE TECHNOLOGY/May 4, 1987

"We always had the feeling that the U.S. would consider that the space station is of such a nature they would not submit the management, or operation or technology control, or even the notion of an equal partnership to control by other nations," d'Allest said.

Europe went through similar debate and discussions on space cooperation with the U.S. in the post-Apollo era during the 1970s, and the result was that Europe developed its own independent launch capability with Ariane. This experience led France to take a tough line on European autonomy in space for the 1990s, and is why the country has pushed for ESA approval of its Ariane 5 launcher and the Hermes spaceplane, d'Allest said. 11

New Chinese Heavy Rocket Spurs Effort To Win Commercial Launch Contracts

By Craig Covault

Washington—The People's Republic of China is beginning a new global campaign to market commercial launch services on its Long March boosters and has begun development of a heavy rocket to spearhead this effort into the 1990s.

China also plans to intensify efforts to buy U.S. and European space hardware as a means of increasing Chinese aerospace technology. The director of China's Great Wall Industry Corp., U. Keli, told AVIATION WEEK & SPACE TECHNOLOGY that China has approved development of a new heavy space booster designed to utilize U.S. upper stages. The Chinese are also upgrading their existing oxygen/hydrogen third stage to place atop the vehicle.

The new CZ-24L booster, set for first flight in 1989, will have a lift-off thrust and weight comparable to the U.S. Saturn IB and a 4,000-5,400-lb. geosynchronous transfer orbit payload comparable to the European Ariane 3/4 vehicles.

The new Chinese booster will be able to place 20,000-lb. payloads in low Earth orbit, a capability somewhat less than a USAF Titan 34D. It is being developed for Chinese military and scientific space needs but also complements China's commercial space market initiative.

Construction of a new launch pad for the 154-ft. booster will begin this fall at the Xichang launch site in southwest China.

Other elements of the Chinese initiative are:

- **New marketing company**—China last week signed its first long-term agreement with a U.S. company to market commercial space launch services.

Chinese CZ-24L heavy booster will have a lift-off thrust and weight comparable to the U.S. Saturn IB rocket and a geosynchronous transfer orbit payload capability comparable to the European Ariane 3/4. First flight is set for 1989 carrying a Chinese satellite, and commercial satellites can use the vehicle starting in 1990. Diagram at left shows the vehicle's four large side-mounted liquid boosters attached to a stretched Long March 2 core. The core will have an additional four engines. The vehicle will generate 1.24 million lb. of lift-off thrust. The side-mounted boosters do not separate but remain connected during first stage flight. Launch shroud (right) for the CZ-24L will be 43.3 ft. long and 13.3 ft. wide. The booster is keyed toward launching the Hughes HS-393 spacecraft or two smaller spacecraft at a time

cial booster launch services. Great Wall signed Becker and Associates, McLean, Va., as sole commercial launch service marketing agent for the U.S., Middle East and Central and South America. Becker is a trade service company.

Ronald D. Wright, president of Becker, said the company will also assist Great Wall in the sale of Chinese electronics to the U.S. and help China import U.S. space technology that could be beneficial to overall Chinese aerospace. He said the Chinese have specifically targeted space technology as a high priority import. U.S. computers, automatic test equipment and switches are on an initial list of aerospace hardware the Chinese want to purchase.

Additional offices—China will establish at least 10 Great Wall launch service marketing offices around the world to sell Long March booster services. Two or three of these offices will be established in the U.S., with New York, Washington and Los Angeles the principal cities under evaluation. Additional offices will be in Europe and South America. The U.S. offices will be staffed with a Chinese representative in connection with Becker and

Associates. Great Wall's director of marketing and development, Huang Zouyi, is expected to be in Washington. He is also a booster engineer.

Hughes negotiations—Chinese Great Wall Industry officials will be at Hughes Aircraft Space and Communications Group this week discussing the arrangements Great Wall can make with Hughes to market and launch the new HS-393 communications satellites. Hughes has done a study on mating the large spacecraft with the new Chinese booster.

The HS-393 is double the size and capability of the earlier HS-376 type and has been designed to allow users of the older HS-376 to transition easily to the higher capability spacecraft during the 1990s. The commercial launch version of the CZ-24L is being developed with the HS-393 as a key element of its marketing strategy, U said.

Upper stage discussions—The Chinese have had preliminary discussions with McDonnell Douglas Astronautics Co. on the mating of payload assist module (PAM) upper stages with the new Chinese booster and plan discussions with

other companies such as Orbital Sciences, Wright said.

Political initiative—The People's Republic of China will offer the Republic of Taiwan a significant cost discount if the Taiwanese government will agree to launch a planned communications satellite on a Long March booster instead of a European Ariane or a U.S. commercial launcher, U said. He said the PRC would charge Taiwan only \$10 million for the launch of its spacecraft into geosynchronous orbit—a \$20-25-million savings compared to the price China is charging Pan Am Pacific and Terasat, the two U.S. companies that have signed Long March launch contracts.

Market projections—Great Wall has identified more than 50 potential commercial satellite payloads that could be launched by its Long March 3 and new CZ-24L booster. Chinese officials have approached 39 companies in 19 nations seeking launch service customers. U said up to eight of those satellites are candidates for launch on Long March boosters over the next five years.

U is leading a Chinese team that will be

Chinese Will Launch French Payload

It is judged that microgravity experiments can be flown on the capsule, Matra will work with the Chinese to offer commercial flight opportunities on Long March 2 and 3 vehicles. A decision on a potential Matra/Chinese commercial effort could be made before the end of 1987 based on results of the August flight.

Chinese officials attending a symposium marking the 25th anniversary of France's CNES space agency here last week said a microgravity-dedicated recoverable capsule could carry 150 kg. (330 kg.) of payload when launched by a Long March 2, while the payload capacity would be increased to 300 kg. (660 lb.) or more when a Long March 3 is used.

The Chinese said two or three commercial microgravity capsule flights could be offered initially per year to meet market demand.

The Matra experiment package to be carried as the piggyback experiment on China's imaging/reconnaissance satellite this August will have a total weight of about 15 kg.

Bao said the Matra experiment package is being flown on a promotional basis, and is part of the growing space cooperation between China and Matra.

in the U.S. until May 8. The team is visiting prospective customers and comparing arrangements with Terasat and Pan Am Pacific. Several other U.S. companies, including Western Union and Dominion Video, have signed non-binding reservations.

One prospective customer is MCI Corp., which requested additional information from both the Chinese and Hughes on launching an HS-393 satellite on the Chinese vehicle.

Money Problems

U said that Terasat has "run into a great deal of financial difficulty" and has been unable to meet its first planned payment to China for its launch, set for the first quarter of 1988.

Production of Terasat's booster has already begun in Shanghai and Beijing, he said. The launch remains on schedule in spite of the payment delay, according to U. Progress payments from Pan Am are scheduled to begin later for that company's scheduled launch from Xichang in late 1988. The Chinese have also signed a contract with Sweden for launch of a small piggyback satellite payload.

The CZ-24L booster will help solidify China's position as a world space power by offering head-to-head competition against large U.S. and European boosters and providing China the capability of launching its own heavy military and civilian satellites. The new booster will also be capable of launching future Chinese manned spacecraft.

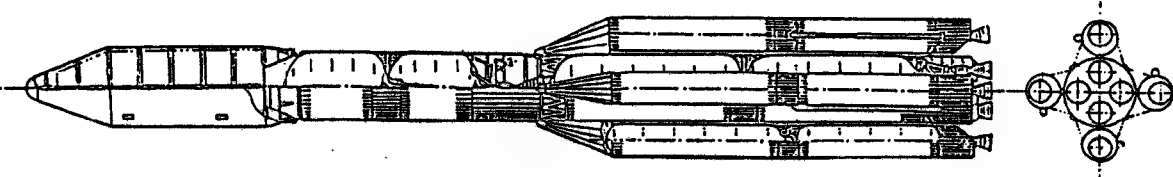
The vehicle's eight first-stage engines will generate 1.24 million lb. of lift-off thrust compared with 1.6 million lb. thrust for the U.S. Saturn IB. Lift-off weight of the new Chinese booster will be about 922,000 lb. compared with 1.2 million lb. for a Saturn IB.

Upper Stage Compatibility

The new vehicle will be compatible with U.S. upper stages such as the McDonnell Douglas PAM, Orbital Sciences AMS apogee maneuvering stage and the RCA Scots shuttle compatible orbital transfer system.

The vehicle's first-stage configuration consists of four large outward engines and tanks surrounding the core vehicle's engine group. The outward engines do not separate during the launch sequence. The vehicle's large launch shroud will be one of its most challenging engineering developments.

About 90% of the new booster's components, including its engines, have been proven on Long March 2/3 vehicles. U



Soviets Lose Proton Booster, Payload in Launch Failure

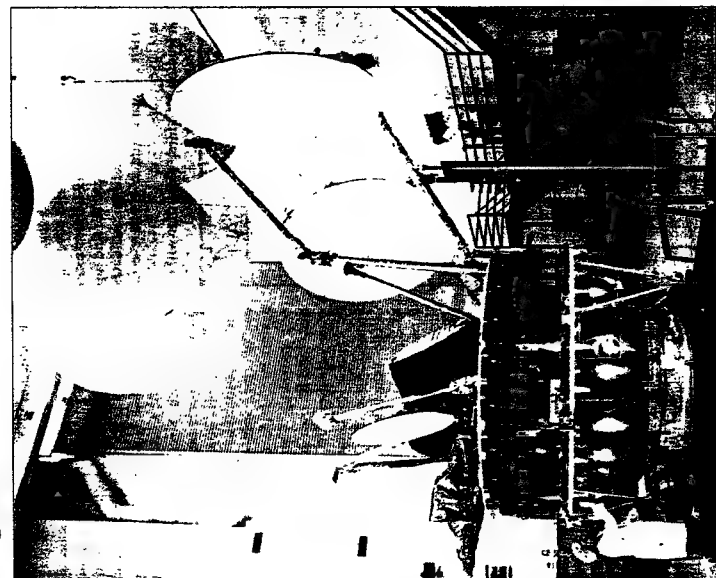
Washington—The Soviet Union has suffered the loss of a heavy Proton booster and its payload of three large navigation satellites during launch from Tyuratam.

The Proton is the world's largest operational booster and the Apr. 24 accident marked the second time in three months that a Proton has malfunctioned, placing its satellite payload in a useless orbit.

The mission was a total loss, costing \$130-200 million. All of the world's largest launch vehicles—the U.S. space shuttle, Titan and Atlas; European Ariane, and Soviet Proton—are grounded now for accident reviews.

The Apr. 24 failure and the earlier Jan. 30 Proton accident were caused by malfunctions in the Proton's fourth stage.

Hughes Tests Intelsat-6 Antenna Reflectors



Antenna reflectors for the first Intelsat-6 spacecraft are deployed during tests at Hughes Aircraft Co.'s Space and Communications Group in which helium-filled balloons are used to offset gravity. Hughes is building five Intelsat-6 spacecraft for the International Telecommunications Satellite Organization, with the first launch scheduled for 1989 on an Ariane 4 booster. The communications systems are shown without the satellite's large cylindrical solar arrays.

Pentagon Describes Possible Military Station Experiments

By Theresa M. Foley

Washington—Defense Dept. has compiled a list of experiments that have grown out of military man-in-space studies begun two years ago, several of which are expected to require the space station.

The candidate military experiments have not turned up any requirements that will cause the station's design to be changed, Charles W. Cook, deputy assistant secretary of the Air Force for space plans and policy, told the annual meeting of the American Institute of Aeronautics and Astronautics last week.

Space Shuttle Use

Cook presented a list of military man-in-space experiments, some of which may require use of the space station, while others could use the space shuttle:

- Spaceborne direct view optical system.
- Latitude/longitude locator system.
- Maritime observations in space.
- U.S. Army space shuttle experiment.
- Space debris belt characterization/mapping.
- Military geology from space.
- Battlefield surveillance from space.
- Launch detection from space.
- Three experiments that would involve the presence of an officer in space to perform atmospheric weather, space environmental weather and space station simulation weather observations.
- Designation from space.
- Free ion remote sensor technology.

The Defense Dept. has taken several steps to develop closer ties to the space station program. Cook said the Air Force has assigned an officer to the NASA Headquarters space station office and about 20 military personnel are supporting NASA's space station operations task force. The Air Force also is a participant in the NASA space station oversight committee.

In addition, the Defense Dept. is involved in two space station-related joint ventures with NASA. The first is the NASA Orbital Maneuvering Vehicle, which will be used to maneuver payloads and vary their orbital inclination in the vicinity of the space station or the space shuttle. The military may buy its own OMV, Cook said.

A second joint project is an on-orbit maintenance and repair effort, codenamed by Cook and space shuttle program chief Rear Adm. Richard H. Truly. While the Defense Dept. is investigating the utility of the station for future servicing missions, "we know the baseline station will

USAF Narrows Contractors For New Upper Stage

Washington—U.S. Air Force Space Div has selected four contractors that will continue to compete for development of a large new upper stage for military space payloads to replace the General Dynamics shuttle/Centaur, which was canceled.

USAF chose General Dynamics, Lockheed, McDonnell Douglas and TRW to enter the next study phase for the Adaptable Space Propulsion System (ASPS) program. Space Div rejected proposals from five other companies. The next phase will be a six-month conceptual design effort.

The program eventually will provide an upper stage that can place 10,000 lb. in geosynchronous orbit from the shuttle and 7,000 lb. with the Titan 4.

A variety of rocket engines remain under evaluation by the contractors for use in the ASPS stage. The Rocketdyne/Aerojet XLR-132 and the Aerojet orbital maneuvering and Transtar engines are all progressing through development for possible application to ASPS.

Bell Aerospace Textron is pursuing an innovative concept with its flight proven

be in the wrong orbit to service mind DOD satellites," Cook said. Such a capability would require expensive additions of hardware to the station, raising questions about how practical military satellite servicing from the station actually would be.

Cook said the Defense Dept.'s basic position of four years ago regarding the station—that it had no real need for it—has not changed. However, other changes, including the Challenger accident, other launch failures, the advent of the Strategic Defense Initiative and the new military space policy, have caused the Defense Dept. to repeatedly evaluate military requirements.

System Architecture Study

A one-year Defense Dept. space systems architecture study done several years ago examined potential station uses and concluded that the station did not fit well with future military space systems, particularly when the survivability issue was considered.

A subsequent study took a different approach by assigning military experts in various fields to develop ideas for station use in their own specialized areas. As a result, in 1985, the Defense Dept. took steps to establish a program called military man-in-space, Cook said. Military man-in-space efforts are a key feature of the new U.S. military space policy signed by Defense Secretary Caspar Weinberger on Feb. 4, directing the De-

Agency engine, which has demonstrated 99.7% reliability over 362 missions extending back 28 years.

The final operational Agena was used earlier this year on the final Titan-3B launched from Vandenberg to place a Satellite Data System spacecraft in orbit. Agenas also have been the mainstay of the USAF/Central Intelligence Agency imaging reconnaissance satellites launched on Titan 34D class launchers.

Bell Aerospace Textron has submitted an unsolicited proposal to Space Div seeking \$4.4 million for development of a powerplant using the basic Agena pumps in a Growth Agena version. The development would produce an Agena derivative with higher performance for the ASPS mission.

The use of new propellants in combination with a smaller injector and chamber and larger nozzle would enable the Growth Agena to provide performance with significant margins over the ASPS minimum requirements. Bell expects to receive Space Div's reply to the request by June.

lense Dept. to actively explore potential military manned space uses (AWSTI Dec. 8, 1986, p. 18; Mar. 16, p. 17).

The policy said, "DOD supports the potential use of military man-in-space DOD will ensure that the unique capabilities that can be derived from the presence of military man-in-space shall be utilized to the extent feasible to perform in-space research and development, and to enhance existing and future missions in the interest of national security. DOD will actively explore roles for military man-in-space focusing on unique or cost-effective contributions to operational missions."

Cook dismissed the notion that Soviet military activities on their space stations are a valid justification for a U.S. military space station. The U.S. has discovered no compelling reason to develop its own military station based on Soviet military space activities, he said.

Cook's remarks were clearly aimed at dispelling some of the recent confusion about Defense Dept. intentions with regard to station.

The recent dispute between NASA and the Defense Dept. over space station international agreement language has resulted in strained relations between the U.S. and its international station partners and raised many questions about military plans to use the station (AWSTI Apr. 20, p. 18; Apr. 27, p. 42). An Air Force official at the AIAA meeting said, "We are

not trying to hide anything. We have no hidden agenda."

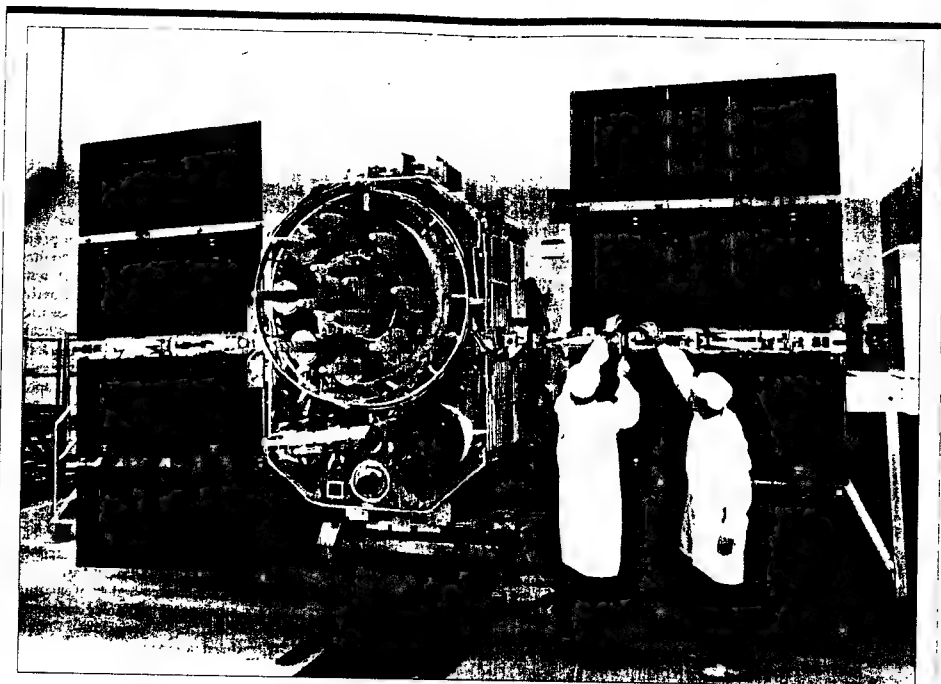
Cook said that while the suggestion has been made that the Defense Dept. could build its own station pressurized module, it is possible that the new two-phase station design would not allow such a change. In any case, it is too early for the Defense Dept. to consider its own module, he said.

The Defense Dept. did not accept any limits to its use of station in the recent agreement it reached with NASA and the State Dept. over international agreement language. Robert Sims, assistant secretary of Defense for public affairs, said recently "We intend to use the space station for those national security purposes that we deem are appropriate," Sims said. The language in the draft agreements does "indeed, protect our national security interests," he said.

Long-range potential military space station applications were described briefly in a lengthy report issued in August, 1986, by the Military Space Transportation Systems Panel of the AIAA. The panel found that the station would "provide an ideal laboratory for development of hardware/operations and for conducting experiments." The military would use the station's pressurized laboratory like any other customer; however, the lab design would have to be adapted to include security provisions, the panel said. "This no doubt may cause problems with currently planned experiments and international users."

The panel suggested that an expendable fluids farm could be located near the station to enhance space servicing capabilities. Another idea would be to cluster pressurized modules near the space station to serve as a logistics depot for military operations. Other modules could be used as dedicated military laboratories and as housing for military personnel. □

26 AVIATION WEEK & SPACE TECHNOLOGY/May 4, 1987



Rockwell Prepares Production Navstar for Shipment

Navstar 13, the first production global positioning system (GPS) spacecraft, is shown at Rockwell International facilities in Seal Beach, Calif., prior to shipment to Cape Canaveral AFS, Fla., where the spacecraft will be placed in storage until its scheduled

launch in October, 1988. Rockwell is under contract to build 28 Block-2 Navstar satellites to support an operational constellation of 21 spacecraft. Present plans call for launching most of the Navstars on the Air Force's new medium launch vehicle.

NASA Issues Station RFPs After Agreeing To Changes Mandated by Congress

Washington—NASA issued requests for proposals for space station hardware Apr. 24 after reaching agreement with Congress to make several station program changes, including an upgrade in power to 75 kw. early in the project.

Bids on the four contracts, which are being managed by the Johnson, Marshall, Lewis and Goddard space centers, are due July 21. Contracts in the multibillion-dollar range are scheduled for award in November, pending a favorable review of the station program in September and October by the Reagan Administration. A National Research Council review that will provide an independent assessment of station costs and technical plans for the White House by the end of August will be headed by former NASA official Robert Seamans.

In addition to boosting the station's power during Phase One from 50 to 75 kw of photovoltaic energy, NASA agreed to accelerate the program slightly and change the layout of the pressurized laboratory to satisfy Congress. The deployment of the station was accelerated by about six months. First element launch is targeted for January-March, 1994, with man-tended capability scheduled for January-March, 1995, and permanently manned capability in the fourth quarter of 1995.

Life sciences equipment that would be disruptive to materials science experiments will not be located in the pressurized laboratory module, a third major change mandated by Congress. Instead, equipment such as centrifuges and animal holding facilities will be placed in a separate module or in one of the station's connecting nodes.

NASA has asked the contractors to

submit proposals with two options to allow it to proceed with the scaled-back Phase One station or the more elaborate dual-keel design.

Incumbent contractors expected to compete for the station work are Rockwell International, McDonnell Douglas Astronautics, Martin Marietta, Boeing Aerospace, Rocketdyne and General Electric Astro Space Div.

Richard N. Malow, House Appropriations Committee staff assistant, said last week at the annual meeting of the American Institute of Aeronautics and Astronautics that another aspect of the station program—lack of adequate early payload funding—troubles committee members. The House panel redirected \$15 million in NASA funds in Fiscal 1987 to microgravity and attached space station payload development, and Malow said he expects those figures to be doubled or tripled in the Fiscal 1988 NASA markup.

Malow predicted the station program will run into trouble in the future because it is perceived by Congress as not being well defined. The station is seen as sharing some of the negative characteristics of the shuttle program, he said. "It tries to do all things for all people and may not do anything well. This program is not home free," he warned.

Malow criticized the White House for its slowness in reviewing the increased space station cost estimates (AW&ST Mar 30, p. 26; Mar 2, p. 26). That delay contributed to the perception in Congress that the station is not well defined. He also raised questions about the strength of space science community support for the station, saying that it does not appear to be as strong as it once was. □

Space Studies Increase Emphasis On Manned U. S. Lunar Base

Washington—NASA Administrator James C. Fletcher has asked study teams examining major new U.S. space goals to intensify assessment of a manned lunar base as a key option that could be presented to President Reagan.

While there is strong interest in a U.S. manned Mars mission, Fletcher wants to be sure lunar base options receive high visibility. Astronaut Sally K. Ride, who is coordinating the studies, also is extremely interested in manned lunar options.

NASA officials do not view the choice as a Moon versus Mars tradeoff since a manned lunar base could be an inherent part of preparations for a Mars mission. Many of the same key technology developments would be required for both.

The U.S./international space station will be key to preparing and launching both missions, a point NASA will stress in the future.

This approach was severely criticized last week during congressional testimony by Planetary Society President Carl Sagan and Bruce Murray, the society's vice president and former director of the Jet Propulsion Laboratory. Sagan and Murray said the current space station design is "not a practical stepping stone to Mars."

They support a U.S. station but called for a redesign to a "more flexible modular approach in which some early applications and research could be carried out while facilities for long-range objectives are built up gradually. The modular step-

by-step approach has served the Soviet Union well."

Sagan and Murray said the current station rationale is based strongly on the "vague notion that space holds great potential for manufacturing" and called for a critical assessment of whether a multi-billion-dollar station should be built to facilitate "extremely dubious space manufacturing endeavors."

NASA wants to initiate a broad new technology development effort to support the lunar and Mars options. This Pathfinder program would be funded by at least several tens of millions of dollars and possibly hundreds of millions. Fletcher told the annual meeting of the American Institute of Aeronautics and Astronautics here last week.

Fletcher said the Pathfinder program, which was rejected from the NASA fiscal 1988 budget by the Office of Management and Budget, could figure prominently in President Reagan's decision on the new space goals. Fletcher said one option would be for Reagan to approve the new space goals package, as well as Fiscal 1988 supplemental funding for the Pathfinder project. Another option would be to initiate Pathfinder in Fiscal 1989.

Another option would be for the White House to support Pathfinder but delay endorsement of a new U.S. space goal, an option Fletcher said would be disappointing.

AVIATION WEEK & SPACE TECHNOLOGY/May 4, 1987

Fixes to Space Shuttle Hardware, Management Reach Critical Stage

By Edward H. Kolcum

Cocoa Beach, Fla.—Redesigned space shuttle solid motor is being tested for an intensified test program that will begin this month as a key element in NASA's recovery from the Challenger accident. The effort involves virtually every hardware and management aspect of the shuttle program.

Gen. W. Smith of Marshall Space Flight Center, manager of the solid rocket booster project, told delegates to the 24th Space Congress that met here recently that the booster redesign is complete and several of the new rocket features already have undergone test on 40-70-lb. motors. The first full-scale firing will be conducted later in May in Utah by Morton Thiokol using existing hardware. A faulty booster joint was the cause of the Challenger accident.

NASA said resumption of shuttle operations will be preceded by a tanking test and a flight readiness firing (Awasit Apr. 13, p. 28). Arnold D. Aldrich, director of the National Space Transportation Program Office, predicted that even with the new tests NASA could launch the next shuttle, designated Mission 26, by early April, 1988. However, many NASA and contractor managers in the field are less optimistic and believe September, 1988, to be more realistic time for systems to be ready for launch.

Wet Countdown Demonstration

The decision to conduct a wet countdown demonstration, which is another name for the tanking test, and a 20-second firing of the three shuttle main engines has been expected. NASA said the tests not only will provide engineering data but also will enable launch and control crews to undergo realistic training after what will be a shutdown of more than two years without a shuttle launch or a live firing demonstration from the pad.

These two tests will add 6-8 weeks to the processing time, but scheduling a launch in April at this time does not account for the impact of orbiter modifications, repairs that might be necessary after the live firing, expected software modifications and the progress of the solid motor testing.

In addition to the shuttle status, several military space developments were highlighted at the space congress, which was held here Apr. 21-24. Among them:

■ A proposal was made by Maj. Gen. Maurice C. Padden, commander of the Air Force Space Command, for smaller, simpler and shorter-lived satellites as a

means to ease production and launching. This also would enable designs to better keep abreast of technology, he believes.

■ Several upcoming satellite programs are introducing new safety issues that require a single manager to assure the safe conduct and control of tests, according to Maj. Gen. Donald L. Cromer, commander of the Space and Missile Test Organization.

■ A space-based radar is urgently needed as the element that ties all space systems together for the military, Rear Adm. Richard C. Macke, commander of the Naval Space Command, said. Macke foresees development of a shipboard antisatellite weapon that also could probably be used as an air defense weapon.

■ The Air Force will manage the advanced launch system, the new name for the heavy-lift launch vehicle, according to Brig. Gen. Donald G. Hard, deputy commander for Launch and Control Systems in the USAF Space Div. Hard said NASA will provide testing and engineering support.

Padden said that complex, long-lived satellites may be detrimental because they would be unable to exploit developing

technology. His concept is for small, easily produced spacecraft with predicted lifetimes of several years. About a year before they are scheduled to decay, they would be replaced by satellites orbited on a schedule, not on demand. The replaced satellites would be put on orbital standby reserve, which he said would complicate an enemy's pinpoint problem because of the large number of relays in orbit.

Bennett, he said, would be the ability to launch with smaller vehicles, and a more stable space funding level.

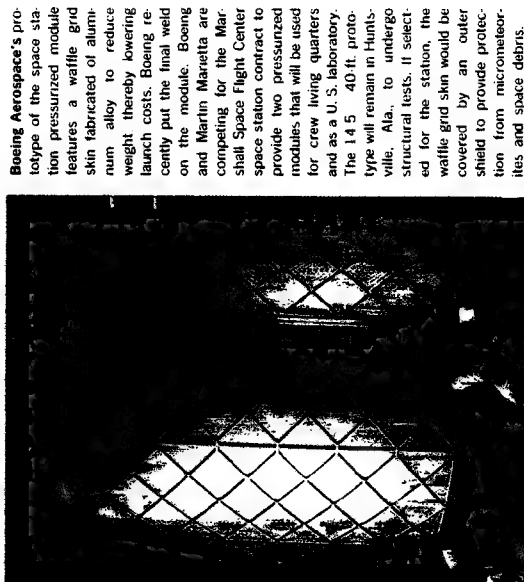
Safety Concerns

In calling for a range safety policy, Cromer said a number of scheduled space programs are causing safety concerns. These are the antisatellite (Asat) program, the Strategic Defense Initiative Organization's Delta 181 payload, the boost-glide vehicle, National Aero-Space Plane and an upcoming SDI end-to-end test.

Delta 181 is scheduled for launch next February and will carry up to a dozen packages that will be tracked by sensors in the second stage of the launch vehicle (Awasit Mar. 30, p. 29).

Cromer said that safety issues include

Module Includes Weight-Saving Feature



Boeing Aerospace's prototype of the space station pressurized module features a waffle grid skin fabricated of aluminum alloy to reduce weight thereby lowering launch costs. Boeing recently put the final weld on the module. Boeing and Martin Marietta are competing for the Marshall Space Flight Center space station contract to provide two pressurized modules that will be used for crew living quarters and as a U.S. laboratory. The 14.5 40-ft prototype will remain in Huntsville, Ala., to undergo structural tests, it selected for the station, the waffle grid skin would be covered by an outer shield to provide protection from micrometeorites and space debris.

ter landing is the least desirable and most unpredictable emergency action. The concept of ejecting crewmen on a pallet through an escape hatch will be available for inclusion in the next shuttle flight, but no decision has been made to modify the orbiter for this escape system, he said. O'Connor said the crew compartment of Challenger hit the water with a force of 20g. Separating the crew cabin and the use of parachutes would affect the performance of the shuttle because of the size and weight penalties.

Conservative Approach

Leonard S. Nicholson of Johnson Space Center, manager of National Space Transportation System Integration and Operations, underscored the conservative approach NASA is taking with regard to shuttle performance. Prior to the Challenger accident, the shuttle had the capability to launch 61,400 lb. from Kennedy into a 110-naut-mi. orbit with a 28.5-deg inclination using 104% of space shuttle main engine power. This was limited to 54,300 lb. by downweight, or the weight that could be landed safely in an orbit situation. The current capability for the same orbit with first refight constraints is 55,000 lb., which will be limited to 50,800 lb. for early flights.

Achievable capability with currently planned hardware, margin testing and analysis for this orbit is 56,000 lb. at 104% of engine power and 61,000 lb. at 109% power. The latter maximum will be limited to 58,000 lb. by downweight limit. The potential capability with hardware upgrades at 109% power is 65,000 lb. The space station orbit is the same 28.5-deg inclination, and altitude is 210 naut. mi. The preaccident capability at 104% power was 46,400 lb. Current capability with constraints is 40,000 lb. Achievable capability at 104% is 41,000 lb., and at 109%, 46,000 lb. With hardware upgrades, a 50,000-lb. capability is foreseen.

A preaccident low-orbit (110 naut mi., 98 deg. inclination) from Vandenberg had a 28,800-lb. capacity. This is now 21,200 lb. With upgrades and 109% power, it could reach 34,700 lb. A space station polar mission to 140 naut mi. had a preaccident capability of 21,600 lb. and a current capability of 14,000 lb. With hardware upgrades and 109% power, payload weight could reach 27,400 lb. into this orbit.

Thomas E. Utzman, director of Space Transportation System Management and Operations at Kennedy Space Center, said the center is moving toward a September checkout of the orbiter Discovery. To date, he said, 57 of 115 scheduled orbiter modifications have been completed and four of 45 ground system modifications are finished. Another 21 are under way. □

Thomas E. Utzman, director of Space Transportation System Management and Operations at Kennedy Space Center, said the center is moving toward a September checkout of the orbiter Discovery. To date, he said, 57 of 115 scheduled orbiter modifications have been completed and four of 45 ground system modifications are finished. Another 21 are under way. □

Thomas E. Utzman, director of Space Transportation System Management and Operations at Kennedy Space Center, said the center is moving toward a September checkout of the orbiter Discovery. To date, he said, 57 of 115 scheduled orbiter modifications have been completed and four of 45 ground system modifications are finished. Another 21 are under way. □

Amroc Official Cites Resistance to Space Commercialization

Cocoa Beach, Fla.—Some government managers will try to slow down space commercialization because it could mean the loss of their jobs, according to William R. Claybaugh, chief financial officer of Amroc Rocket Co., Camarillo, Calif.

Speaking at the 24th meeting of the Space Congress here, Claybaugh said that on government programs, for every producer "there are four guys carrying clip boards"—referring to what he considers the large number of superannuated on NASA and military launch programs.

He said it is the nature of a government specification that the product must be costly. He said people in "government organizations" are "knocking down our doors to talk to us" about launching payloads because his company will not build to military specifications. By government agencies, he said he meant the Defense Advanced Research Projects Agency and the Strategic Defense Initiative.

In addition to job losses, space commercialization has a problem in data disclosure, he said. "There is no way I'm going to give up our trade secrets to launch. There will be no communication on that."

At the same session, Gilbert W. Keyes, director of Commercial Space Products at Boeing Aerospace Co., said commercial space will stand or fall solely on conventional business practices. "Efforts to improve commercialization should be focused on stimulating the right business conditions," he said. When these conditions are favorable, space commercialization "will be hard to stop."

Courtney Stadd, director of Commercial Space Transportation at the Transportation Dept., said he found after circulating the initial draft on the use of government launch facilities by commercial enterprises that the provisions were overly restrictive of government interests. He said the Transportation Dept. wants to insure a streamlined launch licensing process, and he anticipates that the regulatory review process will be made final shortly.

Claybaugh said that someone eventually will come up with a way to launch a 1,000 lb. out of Kennedy and 3,000 lb. from Vandenberg for \$8 million. "And if you buy three launchers, we'll sell you the fourth for \$6 million. He said "But do we want to do it by commercializing an old military vehicle, or by developing a true commercial launch vehicle?"

American Rocket Co. is developing a hybrid propulsion design to meet what it believes will be a market for 100 payloads a year in the 1,000-4,000 lb. range.

Soviet Kvant Astrophysics Module To Observe Deep Space Targets

Soviet Kvant astrophysics module docked to the Mir space station is about to initiate observations reminiscent of those conducted with solar telescopes on board the U.S. Skylab space station nearly 15 years ago.

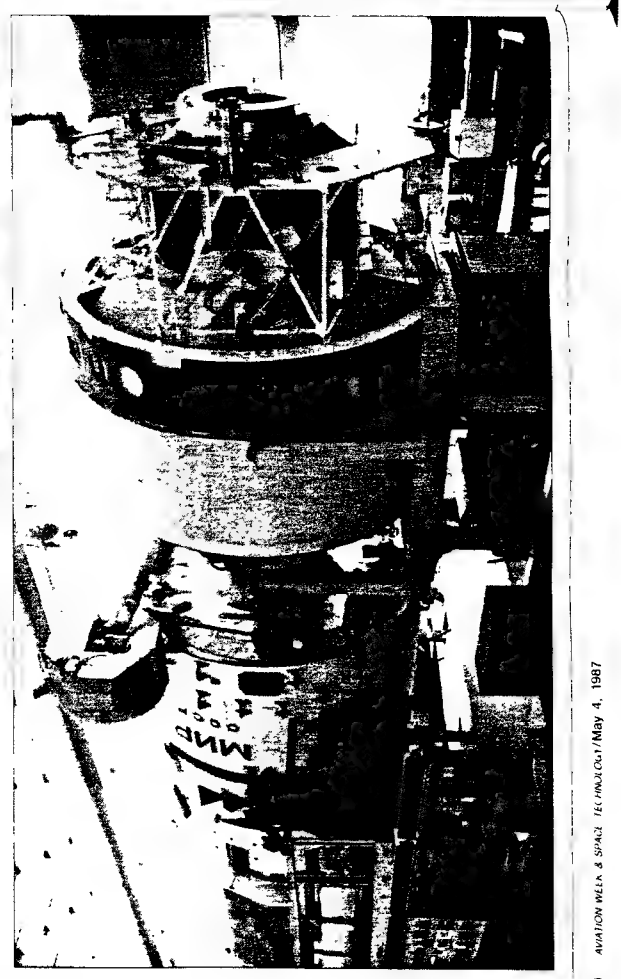
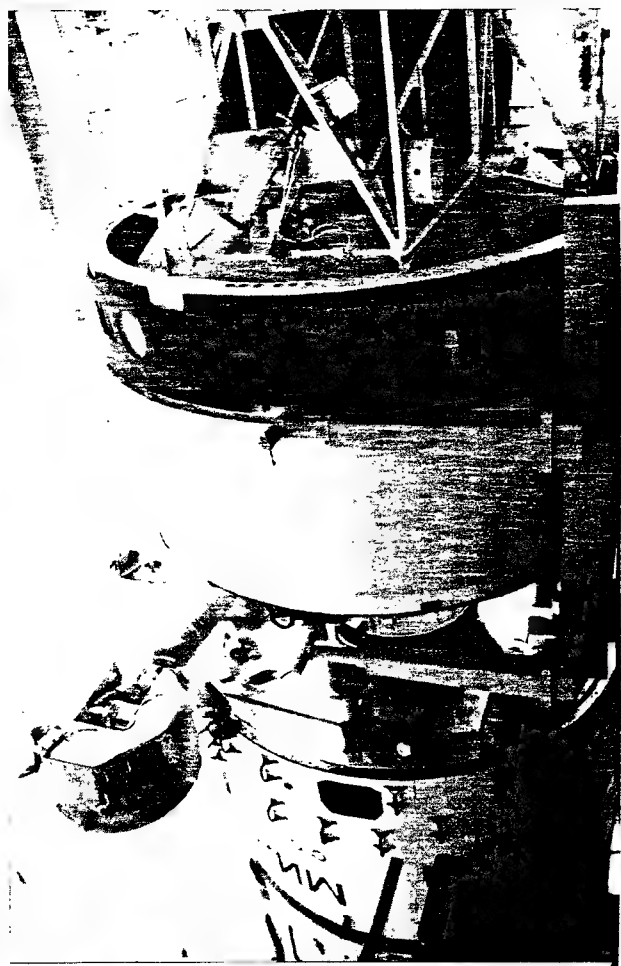
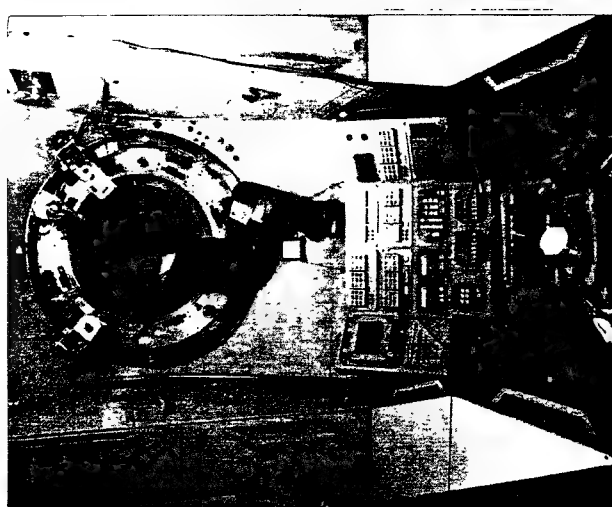
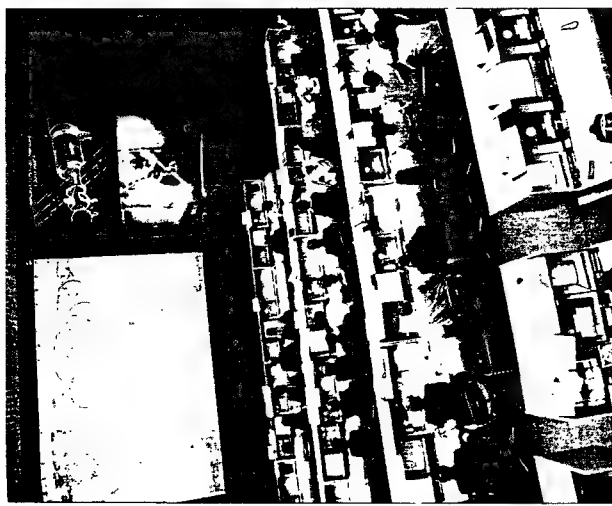
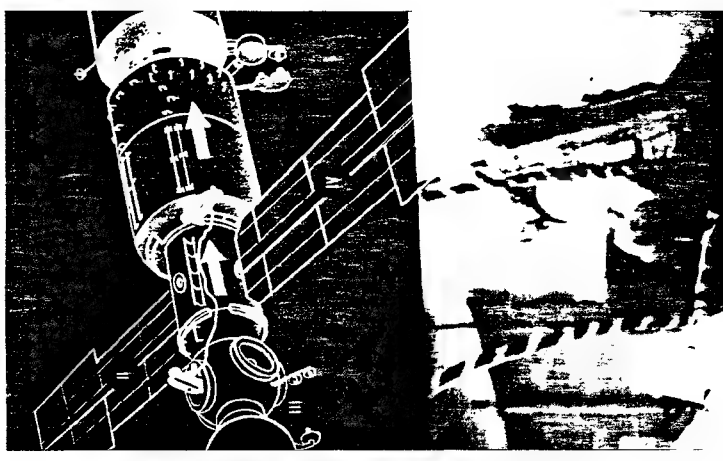
A mockup of the Kvant (below and far right bottom) is shown docked to the Mir mockup at the Star City Gagarin Cosmonaut Training Center outside Moscow. The large spherical module will focus its instruments on a recently discovered supernova and other deep space targets. Note the large boom-mounted rendezvous radar at the juncture of the module and Mir, as well as the docking system and transfer tunnel at the far left side of the module.

This docking system and tunnel will allow additional Soyuz manned transports or Progress tankers to be attached to the station complex.

Interior of the Kvant module (right this page) includes a control and display panel similar to the one used to command the solar telescopes carried by the Apollo Telescope Mount on Skylab. The panel will enable Mir's cosmonaut crew to coordinate the European Space Agency, Dutch, West German and Soviet astrophysics instruments in the module.

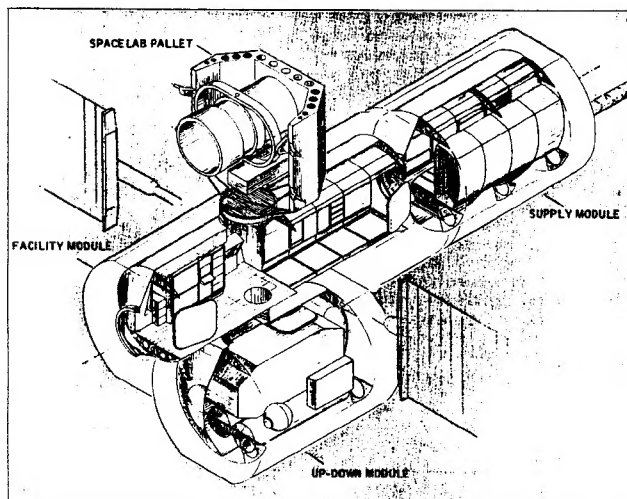
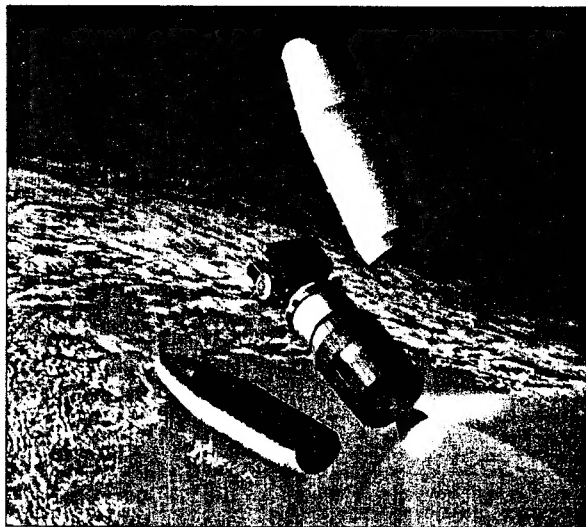
The Soviet mission control center (top center) is shown during the emergency extravehicular activity conducted Apr. 12 by cosmonauts Yuri Romanenko and Alexander Laveikin when cloth debris fouled Kvant's docking hardware. Diagram (top far right) shows how the cosmonauts emerged from Mir's forward docking hub then moved rearward along the station to reach Kvant nearly out of view at far right in the diagram. Lower portion of the diagram shows television views of the EVA.

A second EVA to Kvant is planned in early May to install solar arrays on the module. Design of Kvant indicates it originally was intended for use with the mothballed Salyut 7 space station, but project delays slipped its use to Mir.



Commercial Space Firms Propose Booster, Free-Flier

Mars Observer spacecraft fairing separates and drops away following launch on a Titan expendable launch vehicle in the Orbital Sciences Corp. artist's concept at right. The Transfer Orbit Stage attached to the satellite will boost it to Mars whether the mission flies on a Titan or the space shuttle. The upper stage supplier, Orbital Sciences, has offered to finance the purchase of a Titan for the mission under a plan that would allow NASA to defer launch vehicle payments (AW&ST Mar. 23, p. 24). If NASA transferred the satellite to an expendable vehicle, it could hold its scheduled 1990 launch date. But if it stays on the shuttle manifest, Mars Observer will be delayed until 1992. The Industrial Space Facility belonging to Space Industries, Inc., could be incorporated into the NASA space station program as a man-tended free-flying platform. The coorbiting free-flying platform that NASA will provide for the station has been deferred to the second phase of the



program, and Space Industries officials believe the ISF offers an alternative that could be delivered earlier and financed privately while providing earlier science results. Cutaway drawing at left depicts the interior of Industrial Space Facility. The facility module is the centerpiece of the module cluster, with a supply module docked to one of the two end ports. The top port has a Spacelab pallet and telescope mounted on it, and the bottom port serves as the docking point for a module that contains fuel and power systems. Defense Dept. experiments could be attached to the exterior ports of the Industrial Space Facility, allowing instruments mounted on a Spacelab pallet to view Earth or space. Space Industries would allow the Defense Dept. to use the facility for research in areas such as materials science, sensors or optics, but would not allow weapons systems to be deployed or tested on the ISF. NASA's space shuttle would be used to deliver the attachable payloads to the ISF.

6 April

An international spaceport is being considered for the Cape York peninsula in Australia by the Queensland government, which is seeking private launch companies interested in establishing operations there. After completing a feasibility study last month the Queensland government named the firm of Touche Ross as project manager for further study.

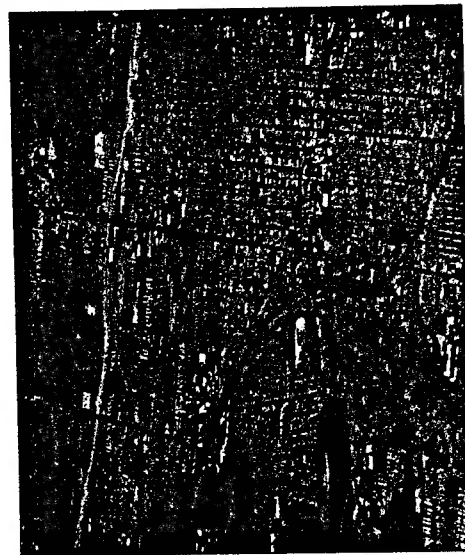
AVIATION WEEK & SPACE TECHNOLOGY/April 20, 1987 13

NASA has turned down Orbital Sciences Corp.'s offer to privately finance a Titan 3 launch vehicle to keep the Mars Observer mission on a 1990 launch schedule (AW&ST Mar. 23, p. 24). NASA officials said they refused the deal because it would have required special legislation authorizing the agency to agree to make payments out of a subsequent budget year.

Voyager aircraft flown around the world by Dick Rutan and Jeanna Yeager last December will be displayed May 9 at an open house at Andrews AFB, outside Washington, D.C., en route to the Paris air show. The aircraft will remain at Andrews for about three weeks, enabling Smithsonian Museum officials to develop detailed procedures for moving it from the base to the downtown National Air and Space Museum later this year. Voyager will be transported to Paris in an Air Force/Lockheed C-5A Galaxy in early June.

27 April

4 May



is designed for use in narrow business jet fuselages. Installation weight is 950 lb. High-resolution KS-157 imagery is capable of detecting humans limbs at 26.3 naut. mi.



LOROP Camera Provides High-Resolution Images of Tucson

Contact print (right) and enlargement of photograph of the Tucson, Ariz., area was shot from a Learjet Model 35 special mission aircraft equipped with a Recon. Optical, Inc., KS-157 long-range oblique angle of 12.8 deg. resulted in 29-naut-mi. standoff range. The KS-157 is a compact, folded version of Recon/Optical's KS-146 LOROP reconnaissance camera system and the picture was taken. A camera depression

Obviously, Xerox can't do this justice...

13 April

A 16-Mb DRAM GRABS THE SPOTLIGHT

The star of last year's ISSCC—the 1-Mb DRAM—was passé by the time the 1987 meeting was held. In this year's DRAM sessions, five out of the seven papers were on 4-Mb devices. Of the remaining two, one was a blockbuster—a 16-Mb chip from NTT Electrical Communications Laboratories. The other concerned a high-speed, low-power 1-Mb bi-CMOS DRAM from Hitachi Ltd.

To achieve its unprecedented density, the NTT 16-Mb chip (see fig. 1) stretches the limits of semiconductor technology in virtually every area: processes and lithography; cell, memory-array, and sense amplifier designs; and error correction.

First of all, the team from the NTT lab in Kanagawa, Japan, used a 0.7- μ m n-well CMOS process to fabricate the basic transistor structures with electron-beam direct-write lithographic techniques. For the memory cell itself, an isolation-merged vertical capacitor structure is used to achieve a cell size of only 4.9 μ m². In this structure, a lattice trench 4- μ m deep is formed to define each cell island, and an isolation region is merged into vertical cell capacitors formed on each cell island's sidewalls. The result is a cell capacitance of about 70 femtofarads, equivalent to that of cells about four times larger.

At the array level, NTT engineers have used what they call a main/sub bit-line structure, which consists of eight 2-Mb arrays. Each main array is divided into four sub-blocks, and each sub-block has a pair of sub-sense circuits arranged in 4-bit-line pitch, making it easy to lay out sense circuits in very small cell pitches. In this structure, the capacitance ratio of a bit line to a memory cell is cut to 6:1, so that very large bit-line signals—approaching 200 mV—can be generated.

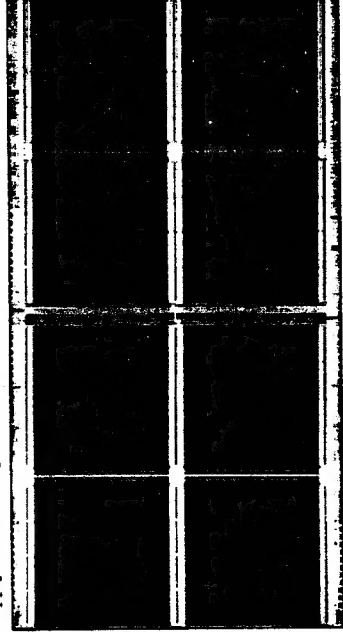
The NTT 16-Mb circuit also represents the first major departure from the 5-V operating supply that has been the standard in the industry for almost 10 years. To avoid such device-physics constraints as punch-through, gate-dielectric breakdown, and hot-electron effects, the chip has been designed for 3.3-V operation. By doing so, the NTT engineers also reduced peak current and power consumption. At 500 mW, the 16-Mb device equals or betters many 1- and 4-Mb devices in these respects.

However, the lower voltage impairs the chip's ability to deal rapidly with the large word-line loads found in megabit memories. So to keep access times in the 80-ns range and cycle times to no more

than 180 ns, the NTT design uses a new sense circuit that incorporates n-channel cell transistors, p-channel flip-flops for data sensing, and pseudo-grounded bit lines for initialization. The result is operating speed—including the rise time of the word line—about 10 ns faster than that of conventional sense-amplifier circuits.

Finally, to deal with the reduction in chip yield because of increased memory-cell defects as array sizes increase, the NTT engineers use selector-line merged error-checking-and-correction circuitry, assigning 33 parity cells to every 256 memory cells. Current error-correction approaches have an access penalty of as much as 20 ns, but the NTT approach uses transmission parity checkers and selectors to reduce this penalty to no more than 5 ns. Data from cells in either horizontal or vertical parity groups are arranged into column circuits without long bus lines by a diagonal assignment technique that assigns each cell in one selector to different horizontal and vertical groups. In such a structure, a parity-checking operation can be carried out at the same time as a data-reading operation. And because these error-correction circuits need no long bus lines—which keeps their load capacitance very small—the access penalty they exact is drastically reduced.

Another DRAM standout at the other end of the megabit spectrum—Hitachi Research Laboratory's 1-Mb bi-CMOS DRAM—is remarkable for its combination of bipolar speed and power-frugal CMOS. It combines a typical access time of 35 ns with a typical power dissipation of only 450 mW. Key breakthroughs that allow such a combination of high performance and low power dissipation include a bi-CMOS device structure that uses twin wells formed in a 1.5- μ m epitaxial layer; the use of fast bipolar transistors throughout for word and column drivers, main amplifiers, and clock drivers; a bi-CMOS clock driver designed to limit on-chip voltage while also reducing power dissipation; and a current-mirror circuit that has been



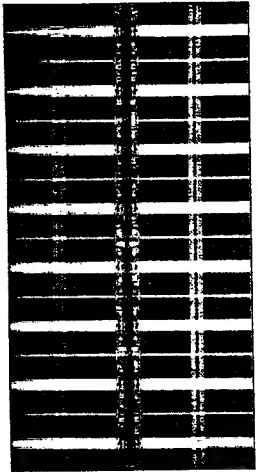
1. BIG ONE. NTT has pushed DRAM density out to the 16-Mb level with its experimental chip, built with e-beam direct writing, trench capacitor structures, and other advanced techniques.

Note to the Reader: There is no loss of detail in this photo — there really is nothing to see!

combined with a voltage-limiting comparator to reduce power dissipation without slowing down the circuit.

Battling it out at the 4-Mb level for fastest access time are chips from Fujitsu, Hitachi, IBM, and Mitsubishi Electric. Checking in with a 90-ns row-address access time, Fujitsu Ltd.'s 4-Mb device uses an 0.8- μ m CMOS process and a folded-bit-line, adaptive-side-wall, isolated-capacitance cell that measures only 10.9 μ m². Hitachi Ltd.'s quicker 70-ns device is fabricated using tighter 0.7- μ m CMOS design rules to achieve a cell size of only 7.5 μ m².

At the 65-ns level, Hitachi and IBM Corp. stick with traditional DRAM structures. In its 0.8- μ m double-well CMOS device, Hitachi achieves its speed with a twisted-drive-line sense amplifier scheme and a multiphase drive-sense circuit. The amplifier setup allows faster operation of the sense amplifiers by effectively halving the load capacitance associated with their drive lines, and the multiphase drive-sense circuit suppresses the power-supply peak current—a significant problem for 4-Mb DRAMs operating from 5-V supplies. The chip is divided into four arrays, with row and column decoders in the middle. The two drive lines for the CMOS sense amplifiers are twisted at the middle of the array, and two p-MOS drivers and two n-MOS drivers are connected to each end of the drive lines. This cuts the capacitance of the drive lines in half, decreasing the associated time constant and yielding sense amplifiers that are twice



2. A FAST 4 MB. IBM has built a 65-ns 4-Mb DRAM with a 0.8- μ m, 3.3-V CMOS process and small cells based on trench capacitors.

as fast as those in traditional configurations.

To achieve high speed in its 4-Mb DRAM (see fig. 2), researchers at IBM's General Technology Division in Essex Junction, VT, combine an 0.8- μ m, 3.3-V n-well CMOS process with a substrate-plate trench cell, formed from a trench capacitor that extends from the surface through the well, through the epitaxial layer, and into the doped substrate. The polysilicon inside the trench is the storage node, and the bulk silicon surrounding the trench is the plate electrode. While the resulting small cell size—about 11 μ m²—would normally reduce the signal level, thus slowing down the circuit, IBM designers counteracted this effect with thick interlayer insulators and narrow metal lines that reduce the bit-line capacitance.

SOLAR CELLS

AT LAST, A CHEAP, EFFICIENT SOLAR CELL

ERLANGEN, WEST GERMANY
The twin thrusts of solar-cell development have been toward lower price and greater efficiency—and usually they have been mutually exclusive. But now researchers in West Germany have taken both routes and come up with a two-sided silicon cell that is both efficient and inexpensive to make.

The researchers, at the University of Erlangen-Nürnberg, believe their experimental devices have pushed solar cells a big step closer to economically viable photovoltaic energy conversion by achieving efficiencies up to 24%. Their goal is 30%; today's one-sided silicon cells are in the 14% range. Though there has been achieved before, getting there required costly materials such as gallium arsenide, expensive processing, or elaborate concentrators that focus light onto the cells' surface.

The key to the high efficiency that Konstanze Jäger and Rudolf Hezel have achieved at the university's Institute for Materials Research in Erlangen is true double-faced construction. Light hits not only the cell's front, but also is reflected onto the specially prepared back surface. Thus, depending on the background, the cell's efficiency is 15% on its

front and 13% to 14% on its rear surface. The two values do not exactly add up but amount to 20% to 24% depending on how the cell is positioned.

The difference between the Erlangen bifacial cell and others developed elsewhere is in the fabrication. The others use elaborate and expensive high-temperature techniques; the Erlangen process is a simple one that involves very thin silicon and low-temperature doping steps. Hezel, the head of the Semiconductor Technology and Photovoltaic Research Group, will discuss it at the 19th IEEE Photovoltaic Specialists Conference in New Orleans, May 4-8.

Like a one-sided cell developed earlier at Erlangen [Electronics, Aug. 7, 1986, p. 38], the bifacial version depends on a

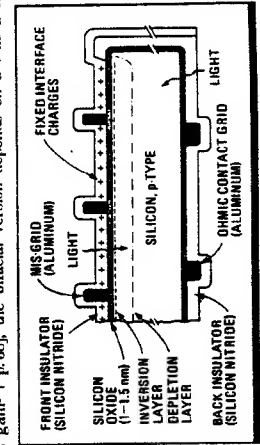
silicon-nitride inversion layer for its operation. But it uses a single- or polycrystalline silicon substrate so thin that the finished cell is only 50 to 80 μ m thick, five to eight times thinner than the earlier cell.

The cell's rear side is passivated with a silicon nitride insulator film that limits the recombination of charge carriers. This permits the light incident on that side to be used for the photovoltaic conversion at only 10% less efficiency than that obtained at the front. The transparent film serves as an antireflection layer and also guards the cell against foreign matter, particularly moisture.

The contribution of the rear surface, Jäger explains, depends on the background's reflection capacity, measured as a ratio of the backscattered light to the light perpendicularly hitting the surface. For both snow and clouds, she says, the value is up to 0.9, for chalk it is 0.85, and for water the ratio can reach 0.7.

The cell's thinness has several advantages, Hezel says. It uses less silicon and is lighter—a big plus for solar panels in space. Also, the cell's operating temperature is reduced, and therefore its efficiency increased, because the sunlight's infrared components go through the cell without being absorbed.

—John Gosch



SUNNY SIDE UP. Bifacial solar cell is made with thin silicon and low-temperature doping and offers up to 24% efficiency.

CPU ARRAYS GO FOR 10 GIGAFLOPS

Four designs for large and powerful multiprocessor arrays stood out among the many general-purpose central processing units and special-purpose processor chips that were described at this year's ISSCC. One of the designs, a two-chip configuration from Digital Equipment Corp., is remarkable for the sheer number of operations per second that a full-scale array built from these chips can pump out: up to 10 gigaflops. Another intriguing design, from the UK's Brunel University, combines multiple computing elements with multiple on-chip

memory elements. And researchers from General Electric Co. and Hitachi Ltd. both presented papers on digital-signal-processing chips that are designed for multiprocessor configurations.

The general-purpose two-chip set from DEC's Hudson, Mass., operation consists of a 32-processor chip (see fig. 7) and a router, both fabricated in 2- μ m double-metal CMOS. It is intended for a massively parallel architecture with up to 262,144 processing elements: 8,192 of the 32-element processor chips, and 384 router chips. This configuration would have a peak performance of 2.6 trillion 4-bit operations/s or 10 billion floating-point operations/s.

The processing-element chip has 242,000 transistors and dissipates only 0.5 W. Each of the 32 individual processing elements on the chip has 1-K of static random-access memory, two shift registers whose size is programmable, a 4-bit adder, an arithmetic logic unit, two 1-bit registers, and neighbor and router communications paths.

A 4-bit operation in each processing element requires 100 ns to execute; therefore one chip can handle 320 million 4-bit operations per second. Operations greater than 4 bits are performed in nibble-serial fashion; for example, 40 million 32-bit operations can be executed in 1 second. Also contained on chip is logic that allows a processing element to operate in a 4-K memory mode by connecting it to the memory of three other processing elements.

Dissipating less than 1.5 W, DEC's companion router chip contains 64 data inputs and 64 data outputs. It allows any processing element to communicate directly

with any other element in the overall machine. An equally impressive chip, aimed at more specialized image-processing tasks, is a 256-element single-instruction, multiple-data-stream parallel processing chip from Brunel University that contains not only eight times as many computing elements but on-chip associative memory as well. Designed for such applications as image enhancement, scene analysis, and pattern recognition, the single-chip array-processing element, or Scape, can execute more than 262 million 8-bit addition operations per second. The 145,000-transistor chip uses a 2- μ m double-metal bulk p-well CMOS process and incorporates 256 fine-grained associative-processing elements. Using a 10-MHz clock, a Scape chip can do a three-by-three 8-bit spatial convolution in 95 μ s, and an 8-bit contrast-switching operation in 8.4 μ s.

Each Scape chip dissipates less than 1 W and contains four types of functional blocks: a single central micro-order generation logic block, four associative memory arrays, two bit-column logic blocks, and four word-control logic blocks. The generation logic block contains a two-level programmable logic array that generates four internal control states per major bus cycle; this block provides overall control of the other processing elements on the chip.

Each associative-memory block contains 64 word rows of 32 data bits each and five flag bits. Each word of local store constitutes an associative-processing element supporting bit-serial and bit-parallel associative-match, write, and read operations. Bit-column access to these blocks is via the two bit-column logic blocks, which incorporate bit-serial data-routing logic and byte- and word-parallel data input/output channels. Conditional bit-masking data-interpretation logic is also incorporated to support bit-serial column addressing over dynamically programmable serial fields set up in the on-chip field-partition register.

The word-control logic blocks do word-row interfacing with the associative-memory blocks. These comprise 256 bit-slice elements that activate word rows of the associative-memory blocks for read or write operations according to a selected mapping of the response to a preceding content search.

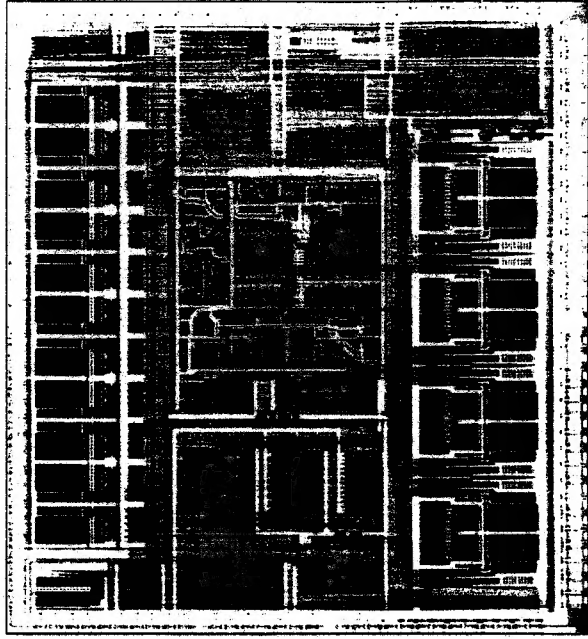
The world of digital signal processing also saw the arrival at ISSCC of two building-block chips for multiple-processor arrays of potentially spectacular performance. Researchers at General Electric's Electronics Laboratory in Syracuse, N. Y., have designed a programmable signal-processing chip for large arrays of 100 to 1,000 elements. Preprogrammed with algorithms for many basic

signal-processing functions, the architecture not only supports many filter topologies but can be used in such applications as fast Fourier transforms, two-dimensional convolutions, and matrix operations.

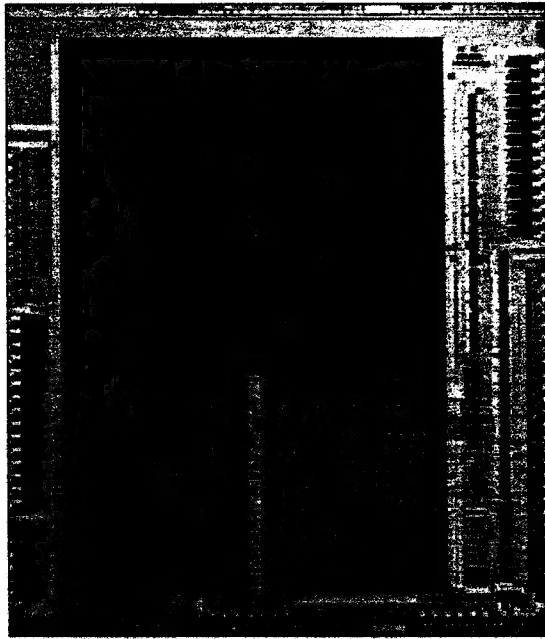
Using a single one of these chips, a 256-point complex floating-point FFT can be completed in less than 400 μ s, and a 256-point finite-impulse-response filtering operation can be performed in 256 clock cycles. Fabricated using a 1.25- μ m double-metal, single-poly-silicon CMOS process, the 155,000-transistor chip contains a 16-by-16-bit multiplier, a 62-by-52-bit control ROM, dual 4-K data-RAM arrays, a 15-word-by-35-bit programmable delay circuit, and miscellaneous adders, registers, and multiplexers.

Hitachi Ltd. is taking aim at multiprocessor applications with its 50-ns DSP chip with a 145-command instruction set (see fig. 8). A single DSP chip from the Tokyo company is capable of performing universal-filter computations at a rate of 50 ns per tap, a 512-point complex FFT in 1.5 ms, and spatial-filter operations at a rate of 400 ns per pixel. Any array of up to 64 by 64 of the Hitachi chips can be connected into a multiprocessor configuration using a host CPU interface. In such a configuration, processing commands can be directed to either individual processors or to rows or columns in the array.

Fabricated using a 1.3- μ m double-metal, single-poly-silicon CMOS process, the 430,000-transistor chip contains a 32-bit ALU with eight 16-bit accumulators, a 16-by-16-bit multiplier, 48-K of internal memory, a barrel shifter, and a parallel I/O interface for communications with a host CPU in multiprocessor applications.



8. **FOR DSP ARRAYS.** Hitachi has developed a 430,000-transistor digital signal processor that can be used in powerful multiprocessor arrays of up to 64 by 64 chips.



7. **MASSIVE PARALLELISM.** DEC has designed a chip with 32 processors on it and a companion chip for routing signals in a system harnessing up to 8,192 of the processor chips.

Electronics

MAGNETO-OPTIC MEMORIES BEGIN TO LOOK LIKE A GOOD BET

SIMPLE NIKON TECHNIQUE PERMITS ERASE AND WRITE IN ONE PASS

The race for dominance in the upcoming generation of high-capacity optical memories is heating up, and a flurry of recent activity is moving magneto-optic disks out of the shadow of magnetic disks. Work in the U.S. and Japan aimed at wiping out the major disadvantage of magneto-optic memories—they require two passes to overwrite, one to erase the old data and the other to record—could at last let eager computer designers take advantage of the considerable edge in density that magneto-optic disks have over magnetic memories.

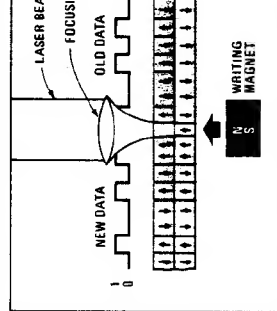
The most recent developments come from Nippon Kogaku K.K., known as Nikon, in Japan; Carnegie Mellon University in Pittsburgh; and IBM Corp. The Carnegie Mellon and IBM techniques require the use of two lasers or one laser with a split beam. So perhaps the most promising new technique is that of Nikon, a newcomer to the disk-drive business, which has perfected a relatively simple and straightforward one-laser solution.

ONE PASS. Nikon engineers made one-pass writing possible by going to a medium with two thin-film magnetic layers (see diagram). The magnetization of the lower layer, terbium iron cobalt, is repeatedly initialized to a downward reference on each pass. This gets it ready to erase 1s, which are stored as magnetization in the upward direction in the upper layer.

The lower layer has the relatively low coercivity of 3.5 kilo-Oe, permitting it to be magnetized in a single direction by a fixed field of 7 kilo-Oe. The upper layer, terbium iron, is the usual film used for magneto-optic recording. It has the high coercivity of 13 kilo-Oe and thus its magnetization is unaffected by that of the lower film at room temperature.

Immediately before writing starts, a given point on the disk always passes over the initializing magnet that resets the magnetization direction in the reference layer. This point then passes under the laser head, at which position there is a relatively weak field of 200 Oe pointing upward.

The laser may have one of two power



PASSING THROUGH. Nikon's system does one-pass erase and write by using a medium with two magnetic layers. The lower layer does the erasing of the 1s stored in the upper layer.

levels, 9 mW to write and 5 mW to erase. At the 5-mW power level, only the upper layer reaches its Curie temperature (the point at which a material no longer exhibits ferromagnetic properties) of 140°C. As it cools down, it is magnetized in the zero state by the reference film. At the 9-mW power level, the lower layer passes through its Curie temperature of 200°C. The low field is sufficient to magnetize both films in the upward direction, the 1 state.

Disks are read at a power level of 1.5 mW. Kerr-effect rotation is 0.3°. Tests show a carrier-to-signal ratio of 54 dB at 1 MHz and 44 dB at 8 MHz. Information density is about one bit/square μm . Experiments were conducted with a track pitch of 1.6 μm and a linear recording density of one bit per 0.84 μm .

In the conventional configuration, an erase head precedes the write head. The track is erased only prior to writing; at all other times the erase laser must be kept off to prevent destruction of data. Moreover, the system must account for the difference in position between the two heads along the track. The Nikon configuration requires no intelligence or control—operation is automatic. The write head has two states, 0 and 1, which is identical with the operation of a magnetic head.

One of the Nikon system's strong points is its compatibility with computer operating systems written for magnetic disks. Development manager Hideki

DISPLAYS

HOW STC IS BOOSTING LCD RESOLUTION

MARLOW, ENGLAND
British company, STC Technology A Ltd., has developed a liquid-crystal material that it says will yield displays offering exceptional sharpness, higher resolution, and a viewing angle of virtually 180°. The key to the sharpness and the high resolution is that the material is stable in both the transparent and opaque states. And the viewing angle—some 20° better than the best reported up to now—is the result of achieving contrast through scattering rather than through polarization.

The stability of the new material, which is in the LC family classified as smectic A, means it does not need refreshing after every 200 or so lines as is common with conventional, unstable, LCDs, a requirement that makes it impractical to have a large number of lines. But with the STC material, there is theoretically no limit to the number of lines. This permits a choice between a large screen or a smaller one with the same number of lines closer together to improve resolution. Initial plans are for the latter: screens with more than 1,000 closely spaced lines, says STC.

At least one expert who has seen a demonstration of the panel reports that the quality of the picture is uncommonly high. "It's more like looking at a piece of paper than at a display," says Peter Batchelor, who is principal engineer at the British Department of Trade and Industry.

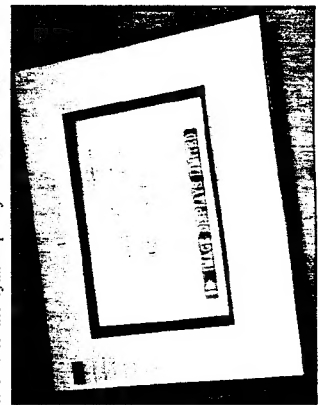
The displays will be aimed at the high-end market for use in such systems as projectors for business conferencing, desktop publishing, and educational work stations. STC is particularly high

on one application: in an overhead projector that would be driven by a computer. The company has not yet set a price for completed panels, but says that they will compete with standard monochrome cathode-ray-tube displays.

Samples of the material, based on cyanobiphenyls, are available from STC in Marlow. But production units will come from a joint-venture company, Image Displays Ltd., when its factory in Cambridge is completed next year [*Electronics*, April 16, 1987, p. 53]. STC formed the joint venture with Alcatel NV of Holland and venture capitalists.

Other LC materials change states by polarizing the molecules. But with STC's material, the job is done by aligning or scrambling them with the application of a high or low frequency to each pixel. A high of about 2 kHz aligns the crystals and makes the screen transparent, and a low of about 100 Hz scrambles them and makes the screen opaque.

Dopants and redox agents are added to the cyanobiphenyl material to facili-



WIDE SCREEN. New liquid-crystal display from STC has on-screen memory and a viewing angle of virtually 180°.

tate dynamic scattering. The liquid crystal must also be doped with an ionomeric material whose mobility along the direction of the smectic layers is greater than its mobility through them. The result, as in nematic dynamic scattering, is that scattering becomes increasingly difficult as the frequency of the applied field goes up. Above about 1 kHz, scattering stops.

The cyanobiphenyl material needs no refresh current because below a certain temperature, that is, well above room temperature, the material is in its stable scattered state—unless voltage is applied. This state can be induced by short-duration monopolar or bipolar pulses, according to the company.

SCREEN BLANKING. The screen is first blanked by scattering the crystals in all the pixels. Information is then scanned onto the screen a layer at a time. When a scan is finished, the row and column voltages fall to zero, since no voltage is needed to maintain the information.

Blanking not only can be done on the whole screen but also on any number of individual rows. It takes about 40 ms for a full blanking. The scanning voltage is applied to the rows and a different voltage is applied to the columns. These voltages are in a square-wave form. If the row voltage is out of phase with the column voltage, the pixel will be cleared; if they are in phase, the pixel will be scattered.

The display needs no special lighting. However, two methods—straight rear illumination and front illumination with a reflective Fresnel backing—are partially suited to overhead or slide projection.

Steve Lagerstrom